Printed by
THACKER'S DIRECTORIES, LTD.,
6, Mangoe Lane, Calcutta.

CONTENTS.

INTRODUCTION.

The Indian Empire stretches from the confines of Persia and Afghanistan on the west to the borders of Siam and China to the east and from latitude 40° or thereabouts almost to the equator. It includes Burma, India proper and Beluchistan, together with the island groups of the Laccadives, Maldives, Andamans and Nicobars. Linked to it by position and tradition if not by present-day administration is to the south the island of Ceylon and to the north are the semi-independent States of Nepal and Bhutan.

In extent the Empire covers approximately 1,800,000 square miles and its population is over 300,000,000 or approximately one-fifth of the whole human race. It includes within itself or on its borders the full length of the vast Himalayan chain with the highest peaks in the world, the great Indo-gangetic plain through which the traveller may pass for 2,000 miles without leaving unfathomable alluvium, plateaus like those of Shillong and Nilgiris famed for their beauty and the rivers Indus, Ganges, Brahmaputra, Irrawaddy and Salween. In the east and south are great forests and strange deltaic regions like the Sundarbans, to the west are deserts now for the first time being called to life over thousands of miles by the vastest irrigation schemes in the world, to the north are mountain, rock, snow and glacier, to the south the palm beaches of Coromandel and the coral reefs of atolls.

In the main the climate is torrid, but in parts, especially in the cool season, it is genial and delightful, and there are places where every year in the winter the passes and routes are blocked with snow. India has a flora worthy of its great physical contrasts and is the natural home of the banyan, toddy palm and mango tree as it is in the north of the deodar, oak and rhododendron. With Ceylon it is the main source of tea production in

the world and is the only source of jute the supply of which is almost restricted to the plains of Bengal; it exports both rice and wheat. It is the home of shikar, of the tiger, wild elephant, bison and rhinoceros, of *Ovis poli* and Himalayan and other bear. Characteristic of it are humped cattle and the water buffalo, and among its beasts of burden are the horse, ox, elephant, camel and yak. It has important coalfields and enormous and as yet scarcely touched deposits of iron. In Burma and in the north-west are petroleum bearing strata and in the south are goldfields.

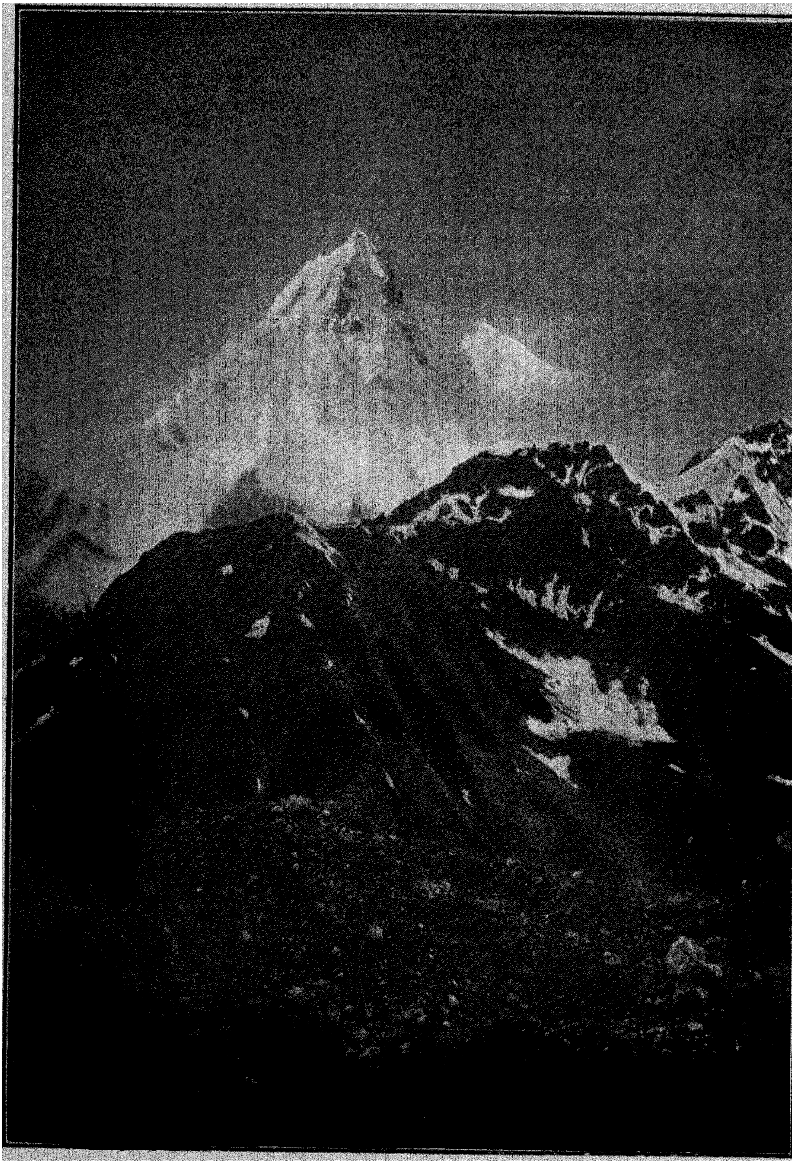
Its people have made a name for themselves in oriental civilisation, in great religions, in sacred writings and philosophical works. In the Vedas and other Sanskrit writings, in the heroic epics of the Ramayana and Mahabarata and in modern poetry they have produced a literature to which the world has done homage. In arts and crafts they have been famous from early times and it is believed that to them has been due the gift to mankind of certain domestic animals and the terraced rice cultivation that now covers so much of the humid lands of the tropical east. As ancient agriculturists its people have felled the forests and converted the land for millions of acres into rice lands and other crops. Its soldiers have given rise to stories of valour renowned through the world and its poets and artists strike a note in imagination which the west can recognise but cannot copy.

To many the East is India and India has given its name not only to the Indies of the east, but to the remote West Indies where men striving to reach the almost fabulous country of diamonds and spices and oriental splendours discovered a new continent.

This book in its different sections gives a very brief account of India, its physical features, population, history, political divisions, zoology, botany, geology, meteorology, etc., and above all as more directly relevant to the Congress its past and present medical and public health activities and organisation. Sections on many subjects are by authorities who are in a position to give most completely in abstract the essence and most recent data on

the matter they are dealing with. If fuller accounts are desired more complete works of reference must be studied. For convenience of readers a list of some of the most useful works in this connection is given as an appendix. A map of India will be found in a pocket inside the cover.

S. R. CHRISTOPHERS,
Editor.



[*Photo by Johnston & Hoffman.*

SINIOLCHU (22,570 feet), A BEAUTIFUL PEAK IN THE HIMALAYA (SIKHIM).

I.

PHYSICAL FEATURES, POPULATION, POLITICAL DIVISIONS, ADMINISTRATION, RAILWAYS, COMMERCE, PRODUCTS AND INDUSTRIES WITH A BRIEF NOTE ON SCENERY AND PLACES OF SPECIAL HISTORICAL OR ARCHÆOLOGICAL INTEREST.

PHYSICAL FEATURES.

INDIA proper is essentially a fragment of a now broken up ancient southern continent separated from its old connection by drift or subsidence of intervening portions and deeply wedged into Asia. Whether this be so, or whether it is Asia that in slow majestic movement has thrust itself upon a deeply rooted immovable India the result has been the same, viz., a vast upheaval of the most gigantic mountain system in the world, the great Himalayan chain and its hinterland the Tibetan plateau. The old land surface of the continental fragment untouched by ocean for countless æons remains the plateau land of Peninsular India, whilst uplifted strata, under the ocean when India proper was still an ancient land, form a northern or Himalayan India. Between these two a gulf or trough filled with alluvium of great depth and extent forms the Indo-Gangetic plain.

The Himalaya.—The characters and scenery of all India are divisible on the basis of these three totally dissimilar regions. In the Himalayan zone are sharp steep eroded ridges, separated by deep trough-like valleys, rising through higher and rockier ridges to peaks of 26,000 feet or over with their attendant snowfields and glaciers. On the outer fringe of this land of mountain, on ridges rising to 7,000 or 8,000 feet are the many hill stations of northern India, Murree, Kasauli,

Simla, Mussoorie, Naini Tal, Darjeeling, etc. The mean height of the main ridge is 20,000 feet, the snow line 16,000 feet on the southern slope and somewhat higher on the northern. The passes average 17,000 feet. The chief peaks passing from east to west are Chumulari (23,944 feet), Kinchinjanga (28,146 feet), Everest (29,002 feet), Dwalagiri (26,826 feet), Nanda Devi (25,661 feet), Nanga Parbat (26,182 feet) and in the Karakorum range, Mount Godwin-Austin (28,250 feet) and others. The rivers Indus, Sutlej and Brahmaputra which drain the northern slopes and flow in troughs parallel to the range on the north break through the range before ending their course in India. The rivers of the Punjab draining into the Indus, as also the Ganges and its northern tributaries arise directly from the southern slopes of the range and make their way through India to the sea.

The Indo-Gangetic Plain.—The great Indo-Gangetic plain is a level unbroken stretch of alluvium with scarcely an outstanding feature from the Bay of Bengal to the Arabian Sea. This is the most fertile portion of India watered by the Ganges and Indus and their many tributaries. An extension of this plain up the Brahmaputra valley constitutes the major part of Assam. Almost everywhere except in parts of Sind and the Thar or Indian Desert this great plain is cultivated. To the east in Bengal and Bihar are vast stretches of rice cultivation, in the central portions are more mixed and varied crops and in the north-west in the Punjab and in Sind wheat is extensively grown, with much rice towards the delta of the Indus.

Peninsular India.—In the peninsular area is raised undulating land of moderate elevation, with tracts of somewhat higher forest covered hills and fragments of loftier mountain plateaus. This portion of India is roughly triangular in shape corresponding to the coastal outline. Its main bulk consists of the old eroded land surface of India forming the central plateau. Only a narrow fringe of low-lying coastal land surrounds this plateau forming the Eastern and Western

Maritime Plains, the latter in places a mere fringe of land a few miles broad.

Aravali Range and Mount Abu.—The central plateau shaped like an equilateral triangle has a somewhat higher elevation at its three corners. The angle to the west constitutes the Aravali Range with Mount Abu lying to the south-east of Rajputana. The rocky spurs of this range extend as far as Delhi where the massive quartzite beds can be seen forming the famous Delhi Ridge.

Chota Nagpur.—The eastern angle constitutes the plateau of Chota Nagpur, on which are situated the towns of Ranchi and Hazaribagh. These stations though of moderate elevation only (somewhat over 2,000 feet) are favourite hot-weather resorts. To the south Chota Nagpur, itself well forested, merges into the wild forested hilly tracts known as Singhbhum, the Orissa and the Jeypore Hill Tracts, etc.

Nilgiris.—The southern angle of the central plataeu corresponding with the south of the peninsula forms the most elevated land outside the limits of the Himalayas. Here are plateaus of 7,000 feet or over, such as the Nilgiri, Anamali and Palni Hills, the first mentioned with the Queen of South Indian Hill Stations, Ootacamund.

Deccan.—The central region of the central plateau, composed of gneisses and a tract of vast basaltic outpourings known as the Deccan Trap, is on the whole level or undulating country largely cultivated and especially given over to cotton wherever the disintegrated Trap gives rise to the characteristic black cotton soil; in parts the land is very fertile and there are numerous areas of forest especially to the north and west. A characteristic feature in many parts consists of isolated rocky ridges of tumbled gigantic boulders, the form which the exposed gneissic rock most frequently takes.

Western Ghauts.—The western edge of the plateau is abruptly cut off in a more or less wall-like fashion and the

horizontal beds of trap thousands of feet in thickness have weathered into the fantastic towers, isolated peaks and precipice-girded bastions of the Western Ghauts, well seen where the different railways crossing India converge upon Bombay and at the towns of Igatpuri, Mahabaleshwar, Mataran, etc.

Eastern Ghauts.—To the east the slope of the plateau is more gradual and here outlying isolated hills and ridges form the so-called Eastern Ghauts.

Satpura and Vindhyan Ranges.—To the north the Deccan merges somewhat gradually into the great plains. This northern portion is crossed from east to west by the Satpura and Vindhyan ranges, hills whose highest points scarcely exceed 3,000 feet altitude, but which nevertheless with their picturesque jungles serve to give a welcome change to the traveller on the main railway routes from Calcutta or the north to Bombay. Here on the eastern extension of the Satpura is the hill station of Pachmarhi situated on a beautiful park-like plateau intersected with deep almost inaccessible gorges worn through the thick sandstone beds. A portion of the Deccan sloping to the north and draining into the Ganges is here called the Malwa plateau. This with the river Chambal is crossed in the train from Delhi to Bombay after leaving Agra and before the Vindhyan range is reached. The States of Indore and Bhopal are situated upon the Malwa plateau which extends through Udaipur to the Aravali range.

Rivers of the Deccan.—The central plateau as a whole slopes to the east, and the rivers almost all flow in accordance with this fact from west to east; of these the most important are the Mahanadi, draining the north-west, the Godavery and Kistna draining the central portion of the Deccan, and the Penner and Cauvary in the south. The rivers Tapti and Nerbudda to the north, however, flow in the opposite direction and passing on either side of the Satpura enter the Gulf of Cambay.

Burma.—Burma unlike the obtruded mass of peninsular India is essentially Asia. Its ridges, folded by the same gigantic pressure as have formed the Himalaya, run north and south entering to the north the knot of mountains to the eastern extremity of the Himalayan chain. From the deep complicated forest-clad valley systems of this inaccessible land pass south into Burma the great rivers Irrawaddy and Salween, the alluvial delta of the former constituting the rich cultivated plain of Lower Burma.

POPULATION.

The total population of India according to the 1921 Census was 318,942,480 persons. This vast population under a single administration is, with the exception of China, unique, the only comparable figures being that for the Russian Empire which is somewhat over one half and that for the United States which is about one-third.

The density of population on the average was in 1921 for all India 177 persons to the square mile. The density, however, in Bengal (population 49 millions) reaches 608, and it approaches this for the United Provinces (45 millions) and Bihar and Orissa (34 millions) where it was 427 and 409 respectively, these provinces like Bengal including a considerable portion of the more fertile tracts. In the Punjab and Bombay the density is respectively 207 and 157 and in Burma (13 millions), where there are large tracts of sparsely inhabited jungle, it is 57 only.

Proportion, Rural and Urban.—The great mass of the population is rural, only about 10 per cent. (32 millions) living in towns. About three-fifths of the population is actually engaged in agriculture. There are nevertheless over 2,000 towns of which 35 can claim to be cities. Two cities, Calcutta and Bombay, have each over one million inhabitants (Calcutta 1,327,547, Bombay 1,175,914). Madras, Hyderabad, Rangoon, Delhi, Lahore, Ahmedabad, Lucknow, Bangalore, Karachi, Cawnpore and Poona have over 200,000 inhabitants.

Villages.—Of villages the number is enormous. In a single district of which there are twenty or thirty at least in a Province the number of villages is usually several thousands. A district which is the administrative unit consists usually of from three to five tahsils and a tahsil may have from several hundreds to 1,500 or more villages. The District Basti in the U. P. has 5 tahsils each with over 1,000 villages and totals in all over 7,000 villages. In all India the number of villages in 1921 was 685,250. If an official, such for example as the Civil Surgeon of the District, were to visit every village in his area once, allowing one hour spent at the village and two hours per village to cover all travelling it would ordinarily take this official, working without intermission twelve hours a day, at least one year to complete his circuit; it might in some cases take two or three years. Yet all these villages have an agent of Government known as the village chaukidar, mukaddam, lambadar, patel, or gaonbura as the case may be in different parts of the country. For every village there is a separate, rough but effective cadastral survey sheet, in every village deaths and births are recorded.

To the north-west of India villages tend to be compact, built of mud or brick with flat mud roof. In the south and east the houses are more scattered, built of wattle or daub or mud with thatch or palm leaf roof. The better class houses are, however, of brick and often have tiled roofs. In Bengal and Assam the houses can scarcely be said to form villages except administratively for they are scattered singly or in little hamlets over perhaps a square mile of rice land and jungle.

Race.—The population of India is of very varied racial characters. In the Punjab and United Provinces the Aryan type is predominant with a large Mahommedan element. Further east in Bengal the Aryan strain is still evident though the racial characters are somewhat distinct from those further west. In south India the population is of the Dravidian type, Telugus in the north and Tamils in the south. Down to the

very point of India in the rich district of Tinnevelly a teeming population still prevails, now characteristically Tamil with quite other features than those of the more aquiline-nosed northern race.

In Chota Nagpur and the regions lying to the south of this are considerable populations of so-called aboriginal (Dravidian) races, Santals, Kols, Mundas, Gonds, Khonds and others.

In the Nilgiris and other parts are still more primitive races such as the Todas, Kurumbas and Irulas. In the Andaman Islands are Negritos of the Bushman type.

Some local races are of foreign origin such as the Parsees of Bombay who were originally immigrants from Persia and the Moplahs of Malabar with Arab blood.

Language.—About 100 languages and dialects are spoken in India. Many of these are Sanskritic such as Hindustani or Urdu, the *lingua franca* of India, which contains much Arabic and is spoken by the large majority of educated persons, Punjabi spoken by about 18 millions in the north-west, Hindi spoken by some 86 millions in the valley of the Ganges, Bengali spoken by about 42 millions in Bengal, Sindhi spoken in Sind, Marathi spoken in the western Deccan and Gujarathi spoken about the Gulf of Cambay. In Assam Assamese is spoken and in the North-West Frontier Pushtu. Of Dravidian languages are Tamil and Telugu, each spoken by about 20 millions, Malayalam, Kanarese and others. In Burma languages of the Burmese group (monosyllabic) are spoken.

POLITICAL DIVISIONS OF INDIA.

For political and administrative purposes India is divided into 15 provinces. Of these 9 are major provinces, viz., Assam, Bengal, Bihar and Orissa, Bombay, Burma, Central Provinces, Madras, Punjab and the United Provinces. These are administered by Local or Provincial Governments. The minor provinces are Ajmer-Merwara, Andamans and Nicobars, Baluchistan, Coorg, Delhi and the North-West Frontier

Province. In addition there are numerous Indian States. Many of these are comparatively or even very small but many are important. Those of large size and having direct relations with Government are: Hyderabad (area 84,258 sq. miles, population, 12,471, 770), Mysore (area 29,475, population, 5,978,892), Baroda and Kashmir and Jammu. Of lesser extent and population are the States of the Central Indian Agency, Gwalior, Indore, Bhopal, etc., States of the Rajputana Agency, Udaipur, Jaipur, Jodhpur, Bharatpur, Bikaner, etc., and States under Local Governments such as Travancore, Cochin, Pudukkottai (Madras), Kolhapur, Cutch (Bombay), Sikkim, Cooch Behar (Bengal), Rampur, Tehri (U. P.), Bahawalpur, Patiala, Nabha, Jind, etc. (Punjab) and various Central Province, Burmese and other States. In all there are 675 such States, of which 175 are under the Supreme Government and 500 under Provincial Governments.

Assam.—Assam was taken from the Burmese by the British in 1824. With some hilly districts to the south it was in 1874 formed into a new province under a Commissioner. Sylhet was afterwards added. Later Assam was made part of the province of Eastern Bengal and Assam, but it is now a separate Government. It comprises Assam proper, or the valley of the Brahmaputra, Cachar and Sylhet—all important centres of tea-production. The capital is Shillong on the Khasia plateau. The country is noticeable for its jungle and vegetation as well as its beauty. The inhabitants lead a quiet, seemingly prosperous and contented life amidst their rice-fields and bamboo groves disturbed only by the ravages of kala-azar. This is specially dealt with by the Assam Government by an Organisation with Treatment Centres in the villages through which 50,000 persons a year have recently received effective modern treatment (intravenous antimony preparations).

Bengal.—Bengal dates its existence as a province from early times. At one time the name was applied to almost the whole of the British possessions in north India. In 1836 the

United (then North-Western) Provinces were separated off. In 1901 the Province included Bihar, Bengal proper, Assam, Chota Nagpur and Orissa with a total population approaching 90 millions. In 1905 the Province of Eastern Bengal and Assam was removed from it and later adjustments by the creation of the new Government of Bihar and Orissa and relinking up of Eastern Bengal have resulted in the Province as at present constituted.

The capital is Calcutta, and there are in addition numerous smaller towns but only one, Dacca, which might be called a city. Bengal is a vast ricefield. Besides rice, jute and tobacco are largely grown. In the Burdwan District are the chief Indian coalfields.

Bihar and Orissa.—Bihar and Orissa was constituted a province in 1912. It consists of three geographically rather distinct portions. Bihar with Patna, the capital, is a portion of the Indo-Gangetic plain lying astride the Ganges and resembling Bengal in that it is extremely fertile and a great rice-producing area. Orissa is a tract including the rich delta of the Mahanadi with Cuttack as the chief town. The province also includes Chota Nagpur, a plateau of about 2,000 feet altitude with the hill stations of Hazaribagh and Ranchi, and certain hilly districts such as Singhbhum, within which there are considerable mineral deposits such as iron, phosphate, etc.

Bombay.—Bombay is the western Presidency of India. It is of old standing, Sind being annexed in 1843. It includes a portion of the Bombay maritime plain or Konkan, a strip of the Deccan lying behind this, Gujarat with the peninsula of Kathiawar and Sind. The Gulf of Cambay and the Runn of Cutch are outstanding geographical features as also the Western Ghauts. Besides Bombay, the capital, there are five towns of over 100,000 inhabitants: Ahmedabad, Karachi, Poona, Sholapur and Surat of which Karachi is also an important seaport. There are about 200 smaller towns. Cotton and grain are the chief agricultural products. Cotton is grown

especially about the Gulf of Cambay (Ahmedabad, Broach) and wheat is extensively grown in Sind.

Burma.—Lower Burma was made a Province under a Chief Commissionership in 1862. Upper Burma was included in 1886 and in 1897 Burma became a Lieutenant-Governorship. The administration besides Burma proper includes the Shan States and the Chin Hills, the former to the east and the latter to the north-west of Burma proper. The capital is Rangoon and besides Mandalay and Moulmein there are about 70 smaller towns. Apart from the plain of the Irrawaddy the country is mostly hilly and largely covered with forest. It is a sparsely populated but rich province with an output of rice, timber, petroleum, etc.

Central Provinces and Berar.—The Central Provinces were constituted in 1861 from the Nagpur Province together with the Saugor and Nerbudda Territories formerly included in the North-Western Provinces (U. P.). Berar was placed under the same administration in 1903. The Province embraces a part of the northern Deccan and Malwa plateau occupying with the Central India Agency States the centre of India. The capital is Nagpur and besides Jubbulpore, a town of 108,000 inhabitants there are about 100 smaller towns. Cotton is extensively grown, also much rice and wheat, etc.

Madras.—Madras Presidency, next to Burma, is the largest of the Provinces and with the Indian States of Hyderabad and Mysore occupies almost the whole of peninsular India south of a line drawn through the level of Bombay. The Presidency has remained very much in extent what it was in 1800 under the Company. Canara, Coimbatore, and the Wynaad were added in 1761, the Northern Circars in 1765 and the Deccan Districts, Anantapur, Bellary, etc., in 1800-1. The capital is Madras (526,911 inhabitants), there are two towns, Madura and Trichinopoly of over 100,000 inhabitants and about 300 small towns. The Province is of very varied physical characters and consists of the Madras districts proper

or Carnatic, the Deccan districts lying between Mysore and Hyderabad, the west coast districts of South Canara and Malabar and the Northern Sircars or Godavery, Vizagapatam and Ganjam districts including the maritime plain and hills behind this as far north as Orissa. Altogether there are 22 districts and a district on an average has an area of 7,000 sq. miles and about 2,000,000 population. The natural resources are considerable and varied. The province supplies a large number of immigrants to Burma, F. M. S. and Ceylon.

North-West Frontier Province.—The province was constituted in 1901. It consists of five divisions and, together with Chitral, the Swat valley and other outlying areas, includes the land lying between the Indus and the high mountains of the Hindu-Kush and Suleiman range. The capital is Peshawar.

Punjab.—The Punjab is the alluvial plain of the five rivers Jhelum, Chenab, Ravi, Beas and Sutlej and part of the Indus basin forming the northern portion of the Indo-Gangetic plain. The Punjab as it existed when taken over was annexed in 1849. In 1858 the Delhi Territory, i.e., the districts of Delhi, Rohtak, Gurgaon, Hissar, Karnal and Ferozpore, was transferred from the North-West Provinces (U. P.). In 1901 the districts west of the Indus were made into the new North-West Frontier Province. Delhi City with a small territory of about the size of a tahsil was in 1911 made an Imperial Enclave, the City becoming the New Capital of India. The present capital is Lahore and besides Amritsar and Rawalpindi, both cities of over 100,000 inhabitants, there are 143 smaller towns. The plain of the Punjab is divided by its rivers into *Doabs* or terrain lying between the rivers. In the enormous irrigation works of the province the main canals run down these Doabs converting what would naturally have been tracts of desert into fertile *canal colonies*. Wheat and cotton is extensively grown and exported and there are many forms of industry such as weaving, horse-breeding and in the hills tea and fruit.

United Provinces.—The province was constituted (as the North-West Provinces) in 1833 from territory formerly forming part of Bengal. In 1853 Saugor and Nerbudda territories were incorporated. Oudh was annexed in 1856. The Delhi and the Saugor and Nerbudda territories were later transferred respectively to the Punjab and Central Provinces. These with other minor changes have left the province, named in 1901 the United Provinces of Agra and Oudh, as it is at present constituted. It consists in the main of the Indo-Gangetic plain from the junction of the Sone and Gandak rivers with the Ganges below Allahabad to the Jumna and there are also the hill regions of Almora, Gahrwal, etc., passing back to the high Himalayan range. The capital is Lucknow (240,566 inhabitants) and there are six other towns over 100,000 inhabitants and 428 smaller towns many of considerable importance. Between the Jumna and Ganges is the Doab; lying north of the Ganges and between this river and Nepal is Oudh. The United Provinces is a very rich and highly developed province. Grain, oilseeds, rice, sugar, cotton, indigo and tea are the chief agricultural products. Cawnpore is a great centre of cotton and leather manufacture. Benares on the Ganges is a famous sacred city of the Hindus.

ADMINISTRATION.

The Supreme authority in India is vested in the Crown acting through a Secretary of State assisted by a Council. There is a High Commissioner for India in London who discharges functions similar to those of the High Commissioners representing the self-governing Dominions.

The administration of the Government of India is vested in the Governor-General in Council who is also Viceroy, assisted by an Executive Council and the Commander-in-Chief as *ex officio* extraordinary member. There is a Council of State and a Legislative Assembly each constituted of nominated and elected members. The six ordinary members of the Executive Council hold portfolios for departments, viz.,

Home, Finance, Education, Health and Lands, Commerce and Railways, Industries and Labour, Law and Legislation.

The executive government of the provinces is constituted (in the case of a major province) by a Governor working (*a*) with Executive Councillors nominated by the Crown, (*b*) with Ministers whom he selects from elected members of the Provincial Legislature. To correspond with this division in the executive the subjects of provincial administration have been divided into "reserved" and "transferred." The transferred subjects include Local Self Government, Education, Medical Administration and Public Health, Agriculture and a number of other subjects.

The administrative unit under the Local Government is ordinarily the district, but with 5 or 6 districts as a rule forming a division under a Commissioner. At the district headquarters, usually the most important town in the district, is stationed the Deputy Commissioner in charge of the district, who, besides being District Magistrate, is responsible for the collection of revenue, control of the treasury, inspection and control of local bodies and municipalities, control of village officials and numerous other duties. Besides the Deputy Commissioner is the Civil Surgeon, usually a member of the Indian Medical Service, a District Health Officer, an Executive Engineer, a Superintendent of Police, Forest Officer and possibly others, conditions not being necessarily the same in different parts of India. At the headquarter town are also the Courts, District Civil Hospital, District Jail, etc. In large districts there may be Sub-Divisional Officers.

A district is divided into tahsils, or taluks as the case may be, and at the tahsil headquarters is the Tahsildar, who is a magistrate and in charge of the revenue collection and Sub-treasury. The tahsil is further sub-divided into smaller divisions variously named in different parts of the country but which correspond to a group of villages and are from say 50 to 100 square miles in area. The ultimate unit for many matters is the village, but there is another unit smaller still, viz., the

numbered plot of land. Very often there may be a thousand or more such plots in a single village, all delimited and numbered and marked on the cadastral map of the village.

For the upkeep of roads, public buildings and other works, education, sanitation, etc., grants from the Provincial Government and the proceeds of local taxation are administered by the District Board (or municipality in case of the larger towns) both of which consist of nominated and elected members.

Of Public Services there is the British Army in India, Imperial State Forces under Indian States, the Royal Indian Marine, the Indian Civil Service, the Indian Medical Service, the Police, the Public Works, Posts and Telegraphs, Forest, Survey, Agricultural, Educational, Ecclesiatical Departments, etc.

RAILWAY, COMMERCE, NATURAL PRODUCTS AND INDUSTRIES.

Railways.—The total length of railways opened in British India and Indian States in 1923 was 37,618 miles, of which 18,389 miles were of standard gauge (5 feet 6 inches), 15,508 miles metre gauge (3 feet 3⅜ inches) and 3,721 miles of other gauges.

The first line opened in India was from Bombay to Kalyan, 33 miles, in 1849. Active railway extension which included the beginnings of the East Indian, Great Indian Peninsula and other important lines began in 1859 and by 1879 nearly 9,000 miles of railway had been opened. At the present time there are through routes linking all the large centres such as Calcutta with Bombay (2 routes, 1,349 and 1,223 miles respectively), Calcutta with Madras (1,032 miles), Calcutta with Simla (1,343 miles), Bombay with Simla (1,230 miles), Bombay with Madras (794 miles), Madras with Ceylon (527 miles). In addition there are innumerable smaller railways, branches and connecting lines covering India proper with a network which leaves but few parts very remote from railway facilities. In Burma the communication is less complete but a line proceeds

from Rangoon to Myitkyina in north Burma (725 miles) and branches from this or independent lines reach many important places.

Commerce.—India is deficient in facilities for natural harbours for vessels of deep draft but possesses five large ports, viz., Karachi, Bombay, Madras, Calcutta and Rangoon. There are, however, innumerable small ports engaged chiefly in coastal traffic (over 400 in the Madras Presidency alone). The annual value of seaborne trade (imports and exports) is about £400,000,000. Of imports the chief are manufactured cotton goods, iron and steel, machinery and railway material, sugar and mineral oil. Of exports the chief are raw and manufactured cotton and jute, grain (especially rice and wheat), oilseeds, tea, hides and skins, wool, lac and mineral oil. In connection with commerce and trade are many important associations, Chambers of Commerce at Calcutta, Bombay, and other places, Indian Jute Mills Association, Indian Tea Association, Indian Mining Association, Planters Associations, etc.

Natural Products.—Of natural products grains of various kinds take first place. Rice is extensively grown in Bengal, Bihar and Orissa, Burma and Madras, and its cultivation is estimated at 80,000,000 acres. Wheat production is about one-tenth of world production, the area under cultivation mainly in the Punjab and Berar being about 30 million acres. Other grains grown very extensively, especially in the Deccan, are the millets *jowar* and *bajra*. Oilseeds are extensively grown (5 million acres). Cultivation of cotton covers about 20 million acres and the cotton grown is estimated at 35 per cent. of the world supply. It is grown chiefly in Bombay Presidency, Central Provinces and Hyderabad. Tobacco is extensively grown in Bengal and exported for manufacture to Burma. Coconut (copra, coir and coconut oil) is an important product in Kathiawar, the Konkan, Godavery delta, etc.

A large trade in hides and skins is carried out. It is estimated that there are 180 million head of cattle and 87

million sheep and goats in India. The skins are collected especially at Calcutta, Cawnpore and Lahore where there are tanneries. Wool is produced in Rajputana.

Timber is an important natural product especially in Burma. Reserve forests cover an area of about a quarter of a million square miles. Some of the more important woods are teak, deodar, sāl and shisham. Lac is cultivated and collected in the jungles. India has practically a monopoly of this product since few other countries produce it and the next most important source, Siam and Indo-China, yields only 2½ per cent. of the quantity from India. Lac is obtained chiefly from Chota Nagpur and its neighbourhood, Sind, Central Assam and Upper Burma. Silk is extensively cultivated in the villages in Assam and elsewhere.

About 50 per cent. of the world's supply of tea comes from India. It is grown especially in Assam, Cachar and the Duars, but also to some extent in the Nilgiris, Kangra valley, etc. Coffee is cultivated in the Nilgiris and other places in south India.

India is a coal-producing country. The coalfields are chiefly in the neighbourhood of Raniganj and Jheria in the Burdwan District of Bengal on the borders of Chota Nagpur and Orissa. Production in 1922 was 19 million tons. Smaller coalfields are in the Central Provinces and elsewhere, usually where the Indian Coal Measures (Gondwana Series) occurs. Tertiary or Cretaceous coal occurs in Assam and elsewhere.

Vast iron deposits (hæmatite) occur in Singhbhum and adjoining tracts. Manganese is obtained from the Central Provinces and elsewhere. Gold is extensively mined in the Kolar Goldfields near Bangalore. Tin, lead, silver, and zinc are worked in Burma where there are also ruby mines. The annual production of petroleum from the Burma oilfield is about 300 million gallons and there are rich oil-bearing strata yielding large quantities at Attock in north-west India. Salt is obtained in large quantities from mines in the Salt Range, etc., and also by evaporation on an immense scale of sea-water

in various Salt Pans on the coast. The tax on salt yields a large revenue.

Manufactures and Industries.—Of large manufacturing or commercial centres the chief are Calcutta (jute mills), Bombay (cotton mills), Ahmedabad (cotton), Cawnpore (leather, woollens, cotton, flour mills, iron foundries, bristle factories, chemical works), Amritsar (piecegoods trade, carpets), Delhi (cotton mills, biscuit and flour mills, art industries, etc.). Of large manufacturing concerns may be mentioned the Bengal Iron and Steel Company who smelt at Kulti (Bengal) and the Tata Iron and Steel Company at Jamshedpur in Bihar and Orissa.

SCENERY AND PLACES OF SPECIAL HISTORICAL AND ARCHÆOLOGICAL INTEREST.

Scenery.—A general account of India would not be complete without some mention however short of scenery and places of interest. The outstanding scenery of India is that of the Himalayas, e.g., in such places as Kashmir, an upland plain of 5,000 feet altitude surrounded by high snow peaks, or Darjeeling, the so-called Queen of Himalayan hill stations, which faces the rock and snow of the vast Kinchinjanga and from which a panorama of hundreds of miles of snow peaks is visible. But many parts have scenery less magnificent but of great character and beauty, such as the Shillong plateau, the Nilgiri plateau, Mahabaleshwar and other places in the Western Ghauts, the plateau and gorges of Pachmarhi, the backwaters of Travancore and other places on the Malabar Coast. Besides which are innumerable scenes of beauty and interest to be seen all over India. Every northern hill station has its panorama of snows, its pine-clad slopes and mountain torrents. In peninsular India are beautiful woodland jungles and rivers with rocks, blue pools and yellow sands. In the east clusters of giant bamboo and jungle amongst which nestle brown homesteads give scenery scarcely to be matched for soft beauty. In the south, too, palms and green ricefields and

curious isolated hills almost everywhere make the scenery both characteristic and beautiful. Even in the featureless great plains the cultivated countryside and the broad sandy river beds and smoothly flowing great rivers have great charm.

Archæological and Historical.—To the scenery is often added the interest of historical and archæological association. In this connection may be mentioned the many relics of the ancient cities of Delhi, the ruins of Fatehpur Sikri nearby, the Forts and Palaces of Delhi and Agra, the Taj Mahal at Agra, the beautiful gardens of Shalimar and Shahdara at Lahore all evidence of the Great Moghul rulers. In Rajputana are medieval forts perched on high inaccessible rocks such as Gwalior Fort seen from the train between Delhi and Bombay, the forts and palaces at Udaipur, Alwar, Mount Abu, etc. In the Ganges valley is the Hindu sacred city of Benares, ruins of Sarnath nearby and the temples of Budh-Gaya, etc. In the west are the cave temples of Elephanta near Bombay, and the less accessible caves of Ajanta and Ellora. To the south are the Hindu temples of Madura, Conjeevaram, etc., characteristic of Dravidian culture and much else of historical and archæological interest.

Among more modern sights are the evidences of the Mutiny at Cawnpore, Lucknow and Delhi.

Modern.—Of quite modern interest are the buildings, green maidans and parks of Calcutta, Bombay, Madras and Rangoon, the Peryar Dam and other irrigation projects, engineering works such as the Kalka-Simla, Darjeeling and Nilgiri railways and the great bridges over the Ganges, Godavery, etc. Also there are the numerous Government, Municipal and Educational buildings and concerns such as the Indian Museum, the Queen Victoria Memorial and the Botanical and Zoological Gardens at Calcutta, the Reclamation Scheme and City Extension at Bombay, the Research Institutes at Pusa, Muktesar, Kasauli, Dehra Dun, Bombay, Madras and elsewhere.

II.

A BRIEF RESUMÉ OF INDIAN HISTORY.

Prehistoric.—Prehistoric remains of man in the form of so-called Neolithic age stone implements have been obtained from many parts of peninsular India and they are especially abundant along the southern border of the Ganges Valley and in the Vindhyan Range. A peculiar form are the "pigmy flints." These occur in great abundance in many parts of India, e.g., the Vindhyan Hills, Godavery basin, Baghelkhand, Rewah, Mirzapur, etc., tumuli, cinder mounds, cup-marks, raddle drawings in caves, etc., also occur. Nothing appears to be known as to the racial type with which such remains are associated, nor is there any known relation of such occupation of the country by early man to history. Nothing resembling a bronze age in India appears to exist. Ruins and sites of very great antiquity such as occur in Mesopotamia and Egypt are not characteristic of India, the earliest known buildings being of the 3rd or 4th century B.C. or later.* Historical data with even an approximately reliable chronology also scarcely exists in respect to India prior to 650 B.C.

Vedic and Sanskrit Periods.—India is, however, peculiar in possessing an early religious literature dealing with events pre-dating actual historical statement. From such writings a great deal has been learnt regarding the origin and early history of the Hindus. Two main periods are clearly indicated in this early literature, the vedic and the Sanskrit (sensu stricto). The chronology of the vedic period is purely conjectural but it is believed to extend from 1500 to 200 B.C. Of the vedic period three literary stages or strata are evidenced, viz., in order of date, the Vedas, Brahmanas and

* See, however, section on archæology.

Sutras. The Vedas which are the oldest consist of four collections, the Rigveda, Samaveda, Yajurveda and Atharvaveda. The Rigveda (1500—1000 B.C.) is the oldest and consists of lyrics mainly in praise of various gods. The Samavedas consist of stanzas of the Rigveda arranged, etc. The Yajurveda, as also the Atharvaveda, is of a later date, though the latter contains matter of a primitive character. The Brahmanas are considered to date from about 800 to 500 B.C. and the Sutras from 500 to 200 B.C.

During the early period of the Rigveda the early Aryan race occupied the north-west corner of India, especially the country of the Upper Indus, i.e., the valleys of the Kabul, Swat River, Kurram, Gomal, etc. At the end of the Rigvedic period the Aryan settlements extended to the Yamuna (Jumna) and Ganga (Ganges); the Narmada (Nerbudda) or the Vindhyan Range is not mentioned. During the vedic period Aryan civilisation overspread the whole of Hindustan, i.e., the country lying north of the Vindhyas and south of the Himalayas. Many of the names of places, etc., are still traceable including Gandhara (preserved in the form of Kandahar), the River Sarasvati (now taken to be the Ghaggar near Ambala), Ayodha (Oudh), Magadha (Bihar), Angas (Bengal), etc. The Yajurveda relates to a period when the centre of Aryan civilisation was in the Ganges Valley (Thanesar, the Doab, etc.). Already in the Yajurveda not only are the four chief castes firmly established, but most of the mixed castes known in later times are referred to.

The Sanskrit period extended from about 200 B.C. to 1000 A.D. It is not, however, a continuation and development of the later vedic stage, but in its commencement ante-dates this. Belonging to this period (500—200 B.C.) are the Mahabharata and the Ramayana the two most famous Indian epics, the former describing the struggles of the Bharatas and Panchalas (Thanesar and Doab area), the latter the adventures of Rama, a prince of Ayodha (Oudh). The Sanskrit period in addition to information derived from internal evidence has a

few chronological landmarks furnished by visits of foreigners, e.g., Alexander's invasion of India in 326 B.C., Megasthenes 300 B.C. who resided for some years in the court of Pataliputra (Patna) and the Chinese Buddhist travellers Fa-hian (399—414 A.D.), Hiuen Tsang (630—45) and I Tsing (671—95 A.D.) whose records are still extant and have all been translated into English.

Darius.—From about 500 B.C. the history of India becomes linked with outside historical events. In the reign of Darius (521—485 B.C.) following an invasion by that king the provinces west of the Indus were made part of the Persian territory. At the time of Alexander's invasion nearly two centuries later the Indus was still the boundary between the Persian dominions and India.

Alexander.—In 326 B.C. Alexander the Great crossed the Hindu Kush and after conquering the country about the Upper Indus, with support from the King of Taxila, invaded India. At this time Taxila was celebrated as one of the greatest cities of the east and a great seat of learning. At the Jhelum Alexander encountered Porus who ruled the populous and fertile territory, containing 300 towns, which lay between the Hydaspes (Jhelum) and the Akesines (Chenab). Here was fought the battle of the Hydaspes in which Alexander was successful. In the forces of Porus were 200 elephants and 300 chariots each drawn by four horses and carrying six men. The foot soldiers carried a broad two handed sword, a long buckler of undressed ox-hide and either javelins or a bow. The archery on the side of the Indians appears to have been unusual for the Greek writers remark that "nothing can resist an Indian archer's shot—neither shield nor breastplate nor any stronger defence if such there be." In July the Chenab was crossed and in August the Hydraotes (Ravi). A battle was fought at Sangala against a confederation of allies from the Central Punjab and Upper Beas in which Alexander was also successful. At the Beas Alexander turned back and again reaching the Jhelum built

himself a fleet and passed down this river to the Indus and the sea.

The Maurya Empire.—The effect of Alexander's invasion, however, was very short-lived for within a few years the whole territory conquered by him to the foot of the Hindu Kush had been reconquered and attached to the kingdom of Magadha. Magadha or Bihar was a Hindu kingdom in the Ganges Valley with its capital at Pataliputra (Patna). The dynasty founded by Sisunaga at Magadha about 600 B.C. is among the earliest in the Puranic (Sanskrit period) with any claim to historic reality. In the time of the fifth monarch of this line, Bimbasara, Magadha conquered and added to its territories the kingdom of Anga (Bhagalpur and Monghyr). This same Bimbasara is famous in Buddhist story as the friend and patron of Gautama Bhudda, who died 487 B.C. in the reign of Bimbasara's successor. The Sisanuga dynasty continued for three or four generations beyond this and was followed about the middle of the fourth century B.C. by the Nanda dynasty. The last of the Nanda dynasty immediately after Alexander's inroad was deposed by Chandragupta Maurya who being at the time in exile in the north-west collected a force in these parts and descended upon Magadha. Chandragupta rapidly reconquered the territory annexed by Alexander and added this to Magadhan possessions. The kingdom at this time extended from the Arabian Sea to the Bay of Bengal and beyond the Indus to the Hindu Kush.

Asoka.—The next king but one following Chandragupta was Asoka (272—231 B.C.). Asoka who reigned for some 40 years is one of the most famous kings in Indian, or indeed general history. His kingdom was that of the Maurya Empire under Chandragupta with the addition of the Northern Circars (Kalinga) which was conquered in his reign. His monolithic pillars inscribed with edicts are to be seen at Delhi and elsewhere in India. Asoka was an ardent follower of Buddha and the early spread of Buddhism is largely due to him. He actively inculcated Buddhism throughout his territories and

encouraged the foundation of Buddhist monasteries. Missionaries were sent to the Chola and Pandya kingdoms in the extreme south and to Ceylon as well as to tributary states on his frontiers and to the various Greek kingdoms.

Brahmanism and Buddhism.—The two religions Brahmanism and Buddhism were at this time and subsequently both in active progress in India. The place of origin of the Brahmanical religion was the sacred country of the Yajurveda, the country of the Kurus or Kurukshetra called Brahmavarta (i.e., modern Thanesar). From here the adherents of the Yajurveda broke up into several schools which gradually extended over other parts of India. Buddhism arose in Magadha which remained Buddhist to the Mohamedan conquest. Elsewhere Brahmanism gradually ousted Buddhism which eventually ceased to be the religion of the country of its origin.

After the death of Asoka the Maurya Empire became dismembered, but the home provinces under the Sunga and Kanva dynasties (184—72 B.C.) remained as the kingdom of Magadha until 27 B.C. when it was annexed by a monarch of the Deccan kingdom of Andhra.

Kushan Dominion.—In 200 B.C. Demetrius the Greek King of Bactria invaded India and annexed the Kabul Valley, Sind and part of the Punjab. Mithridates I, the Parthian King also annexed the Western Punjab about 138 B.C. In 45 A.D. both these powers were destroyed by the inroad of the Kushan clan of the Yueh Chi horde from Central Asia which first established itself under Kadphyses I in the north-west, and then under Kadphyses II (85 A.D.) conquered India to the east and south at least as far as Benares. Kadphyses II was succeeded by Kanishka (125 A.D.) famous in Buddhist legend as a second Asoka. Under Kanishka the Kushan kingdom greatly extended itself, his dominions including the plains north and south of the Oxus, most of modern Afghanistan, Kashmir and a large part of North India. His capital was

Peshawar which became the centre of a great school of Indo-Roman Buddhist art. The Kushan kingdom was maintained under Huvishka (150 A.D.) but in the time of his successor Vasudeva (185 A.D.) became restricted to the Punjab where it continued to exist until the time of the Hun invasions in the 5th century.

Gupta Dynasty.—Whilst the Kuchan kingdom had thus dwindled to the Punjab, what was practically the old kingdom of Magadha again extended itself under the Gupta dynasty (320 A.D.). The second king of this dynasty Samudragupta (326 A.D.) by conquests extended his kingdom from the Brahmaputra to the Sutlej and held Malwa and Rajputana and a portion of Lower Bengal under tribute. With this was also a temporary conquest of two kingdoms to the south of the Vindhyas and inclusion within his frontier of territory as far south as the Nerbudda. Samudragupta II (390 A.D.) annexed Malwa and Kathiawar, thus extinguishing the Satrap Greek dynasty in this peninsula which had existed as a powerful state for three centuries. It was in the reign of Samudragupta II that the Chinese Buddhist pilgrim Fa-hian visited India. Pataliputra was still a flourishing city and a great centre of the two forms of Buddhism. Numerous Buddhist monasteries existed and what is modern Bihar, U. P. and Malwa was the scene of great prosperity and equitable administration. Kamaragupta and Skandagupta in turn succeeded to the throne but both had to struggle with the invasions of the White Huns and at Skandagupta's death the Gupta Empire disappeared. (480 A.D.)

Mediæval India.—During the 6th century, following the break up of the Gupta Empire and as a result of the invasions of the White Huns, India became divided up into many petty kingdoms. During this time the jungles extended and the ancient capitals lay in ruins. The north of Oudh was forest and jungle reached to the neighbourhood of Benares. Another great forest stretched from Bihar to Rewah and there were famous forests in the Upper Doab and about Thanesar.

Indo-Scythians had established their dominion from Peshawar to Muttra, Parthians ruled in Gujarat and the Lower Indus. The parts about the Doab and Eastern Punjab still, however, maintained a stable government and a dense population. Here in the 7th century rose the kingdom of Kanauj, ruled by the great King Harsha (also known as Harshavardhana Siladitya). Harsha ascended the throne of Thanesar about 604 A.D. After conquering Northern India he attempted the subjugation of the South but was held south of the Nerbudda by the power of Pulakesin II the Chalukya King of the Deccan. During Harsha's reign the Chinese traveller Hinen Tsiang teacher of the Mahayana form of Buddhism visited India. At this time territories west of the Indus including Gandhara were under a king of Northern Afghanistan and part of the Punjab was under Kashmir. The rest of Northern India including the King of Assam acknowledged Harsha's rule. Pataliputra was in ruins. The most prosperous parts were Magadha (Bihar), Western Malwa and Gujarat. The Nepalese Terai was waste and Kalinga (Northern Circars) was thinly inhabited and supposed to lie under a curse. Buddhism was showing signs of decay but still held in the Punjab, Kashmir and the North-West. Orthodox Hinduism was predominant in the Ganges Valley and the Jains were numerous in Eastern Bengal. Harsha's throne was usurped by Arjuna (648 A.D.). A Chinese envoy was badly received at the time of Harsha's death and escaping to Tibet returned with a force of Tibetans and Nepalese, captured Arjuna and took him a prisoner to China. Once more Northern India (650 to 950 A.D.) relapsed into a congery of small states engaged in unceasing internecine war.

During the 7th to 11th centuries A.D. India passed under the influence of Neo-Hinduism. Siva and Krishna and a vast polytheism took the place of the older vedic deities. The Mahabharata and Ramayana (product of the Gupta period) with the Puranas or old tales formed the textbooks of the new religion. The four original castes underwent a new division

and the Brahmans and Rajputs became supreme. The Rajputs made their first appearance in the 8th and 9th centuries and most of the clans took possession of their future seats between 800 and 850. From Rajputana they entered the Punjab and made their way to Kashmir. About the same time they spread north and east from Southern Oudh and later made themselves masters of the Central Himalaya. Kashmir now rose to power and ruled part of the Punjab. The Sambhar kings ruled over the country from Mount Abu to Hissar with Ajmer as their capital, and their territory was extended during the 12th century to include Delhi and what was left of Kanauj. During this time the Gujars pastoral tribes of Scythian origin founded petty states in the Punjab, Central Rajputana and Gujarat. The Western Punjab was under the kings of Ohind with their capital at Lahore. In Bengal were the various kingdoms of Pundra (Pabna), Vanga (Bengal proper). Karna Savarna (Burdwan, Murshidabad, etc.), Tamralipta (Midnapore) and Anga (Bhagalpur). Magadha still continued in existence until overthrown by the Mohamedans in 1196. This was the only Buddhist kingdom then in Northern India.

It was at this stage that the Mohamedan conquest of North India took place.

The Deccan, Telugu and Tamil Kingdoms.—Before going on to the Mohamedan conquest of North and South India a brief reference to the Hindu kingdoms south of the Vindhyas is necessary. The Dravidian population of Southern India were, during the early periods B.C., subdued by Aryan conquerors who seized on the old kingdoms and established dynasties throughout the area. Among these kingdoms known in the time of Asoka (250 B.C.) were the Andras (Godavery and Kistna basins), the Pulindas (Nerbudda), the Petenikas (Aurangabad), the Rastikas (predecessors of the Rastrakutas and Rattas, Mahratta country), the Bhojas and Asparantas (Bombay), the Cheras or Keralas (West coast), the Cholas (Tanjore) and the Pandyas (Madura). A large

part of the Deccan was almost uninhabited and known as Dandakaranya or the desert of Dandara.

Andhra.—The supremacy of the Andra kingdom dates from about 180 B.C. The capital was Dhanyakalaka on the Kistna where was constructed the famous Amaravati stupa (near Bezwada). In the west was a second capital Paithan (near Aurungabad). The kingdom comprised all middle India and extended from sea to sea with the great Tamil kingdoms to the south. Andhra had a considerable trade both overland and by sea with Western Asia, Greece, Rome and Egypt as well as with China and the East. Roman coins are found in profusion in the peninsula and Pliny mentions the vast quantity of specie which found its way from Rome to India.

But by the end of the 5th century A.D. Andhra was no longer a great power. At this time the southern kingdoms were much as before but the Pallavas whose capital was Conjeeveram near Madras had overspread a large part of what had formerly been Andhra and to the north as an independent power were the Rastrakutas occupying the country on both sides of the Vindhyas. To the south of the Rastrakutas occupying the country about Dharwar were the Kadambas who in the 6th century after defeating the Pallavas and the Ganga King of Mysore settled in the southern Mahratta country bordering on Mysore.

The Western and Eastern Chalukyas.—Under Kirttivarma I (566 A.D.) there now rose a new power in the west. Under Kirttivarma the Chalukyas conquered widely and under Pulikesin II (609 A.D.) they became masters of a large part of the peninsula. Conquering the Konkan, Deccan and Northern Circars they crushed for a time the Rastrakutas and invaded even the southern kingdoms of the Cholas and Pandyas. It was in the time of this king in the zenith of his power that Harsha, King of Kanauj, endeavoured to make conquests in South India but was repulsed. After Pulikesin's reign the kingdom was divided into a western portion with the

capital at Badami (in the south of the Bombay Presidency near Belgaum) and an eastern portion with the capital at Vengi between the Godavery and Kistna.

The Rastrakutas.—At the end of the 8th century the western portion of the Chalukya kingdom had been for the time destroyed (760 A.D.) by the Rastrakuta king, Krishna I, and the Rastrakutas held sway over the centre and west of the Deccan as well as over a considerable part of southern territory. The Eastern Deccan and Kalinga (Northern Circars) still remained under the eastern Chalukyas. In the south were the Chola and Pandya kingdoms. Mysore was under a Ganga dynasty.

Sack of Anuradhapura.— In the reign of Sena I of Ceylon (846—66 A.D.) the Pandyas attacked Ceylon and sacked the city of Anuradhapura, but a few years later Sena II captured and plundered Madura. In 962—70 A.D. Ceylon was again invaded by the Pandyas.

At the end of the 10th century the Rastrakuta kingdom was broken up due to the rise again to power of the western Chalukyas under Taila II. At the same time the Cholas became very powerful and under Rajaraja I (985—1012 A.D.) overran eastern Chalukyan territory and Kalinga, defeated Ganga King of Mysore, overcame the Pandyas and invaded Ceylon. There thus were about 1000 A.D. two new powers, the resurrected western Chalukyas with their capital at Kalyan near Bombay and the Cholas (now amalgamated with the eastern Chalukyas) with their capital at Kanchi (Conjeeveram, near Madras). The Pallavas of this latter area have disappeared.

But in 1192 the western Chalukya dynasty was swept out of existence by the Yadavas on the north and the Hoysalas from the south and the Kakatiyas of Warangal (Hyderabad) had also come into power and conquered Chola territory.

The Hoysalas.—The Hoysalas under Vishnuvardana *alias* Bittiga destroyed the Ganga dynasty of Mysore and under Ballala II (1191—1211) established themselves as rulers

over a large part of the Deccan, struggling for supremacy against the Yadavas. The Hoysalas made conquests in the south against the Cholas but lost in the north against the Yadavas. The Hoysala capital some time prior to 1242 was moved to Vikramapura (Cannanore) in Malabar.

The Yadavas.—The Yadavas whose capital was Deogiri (modern Daulatabad near Aurungabad in the Western Deccan) made conquests in Gujarat and Malwa and later to the south. Eventually in the reign of Ramachandra they seized the old capital Dorasamudra (modern Halebid north-west of Bangalore) of the Hoysalas. The Yadavas governed the territories formerly held by the western Chalukyas, the Konkan and parts of Mysore. To the east of them was Warangal and to the south the Cholas.

The Yadava dynasty ended after the seizure of its last ruler by Kutb-ud-din Mubarak, Emperor of Delhi. The territory of the Hoysalas was annexed in 1327 and the Mohamedan conquest of the South had begun.

The Southern Hindu Kingdom.—The last stand against the Mohamedans was made by a confederation of southern kingdoms under the leadership of two brothers, Harihara and Bukka. These in a few years established an empire which kept the Mohamedans at bay for two centuries. The capital was the new city of Vijayanagar in Kanara which became one of the largest and wealthiest cities ever occupied by Hindus.

Mohamedan incursions and conquest.—Mohammed died in 632 A.D. and within a few years of this date Syria, Egypt and Persia were added to Mohamedan dominion. In 712 India was invaded through Mekran and Baluchistan and Sind and Multan annexed. In 870 these provinces together with Seistan and Kerman formed a Mohamedan kingdom. But in 1051 rule passed to a local dynasty and Mohamedan dominion was on the wane if it had not ceased altogether.

Ghazni Kings.—In 999—1025 Mahmud ruler of a state of which Ghazni near Kabul in Afghanistan was capital made

repeated incursions into India in the course of which he took many towns in the Punjab, reduced Kanauj as well as plundered widely. As a result at the end of this period the Punjab formed the frontier state of Ghazni. Later when Ghazni territory to the north was lost to the Ghori kings, Mahmud's successors moved their capital to Lahore (1160) but their power was shortly ended by the same Ghori kings (1186).

Ghori Kings.—The Ghori kings ruled in the country between Ghazni and Herat in the north-west. Ghiyas-ud-din Muhammed came to the Ghori throne in 1162 and eleven years later annexed Ghazni leaving his younger brother Mu'uzz-ud-din in charge of the conquered territory. Mu'uzz-ud-din almost at once began conquests in India. He made various excursions into the Punjab and took possession of Sind, Multan, Lahore, etc. (1186). In 1191 Mu'uzz-ud-din gathered an army for the conquest of India but was met and defeated by Prithwi Raj, the last of the Sambhar kings and ruler of Delhi and Agra. Next year, however, Mu'uzz-ud-din was successful and taking Prithwi Raj prisoner annexed his territory (except Delhi). Later his general Qutb-ud-din took Meerut and Delhi where the capital was established. In 1194 Mu'uzz-ud-din overthrew Raja Jai Chand, Rathor, ruler of Kanauj and pushing on sacked Benares. By 1206 when Mu'uzz-ud-din was murdered, Northern India from Peshawar to the Bay of Bengal was held by satraps, the four most important of whom were, Qutb-ud-din holding Delhi and Lahore, Taj-ud-din in the Kurram Valley, Nasir-ud-din in Multan and Sind and Muhammed, son of Bakhtyar at Laknauti (Malda) in Bengal. Delhi, however, was the most powerful and soon assumed supremacy under the Delhi kings.

Delhi Kings.—34 kings reigned at Delhi 1206—1526 of which 12 were deposed or assassinated but without any outside influence coming into play. These kings are divided into five houses which include the so-called Slave Kings of Delhi (1206—1290), since Qutb-ud-din the first ruler was a slave, and the Lodi kings who terminated the series. Qutb-ud-din was

responsible for commencing the Qutb mosque and the famous Qutb Minar near Delhi and many of the antiquities of Delhi are of this period. Ala-ud-din, a king of the Khalji or the second of the Delhi dynasties, first as generalissimo and later as monarch led the first Mohamedan armies into the Deccan. He sacked Daulatabad and Ellichpur and instituted systematic incursions into the south. In 1297-8 his forces traversed Gujarat. Chitor was captured in 1303. In 1307 Deogiri (Daulatabad) capital of the Yadavas was taken and in 1310 Warangal. In 1311 Ballala Raya's capital of Dwarasamudra was taken (Mysore). In the days of Mahmud the last of the Tughlaqs (1398—1413) the Delhi kingdom began to fall to pieces. Gujarat, Malwa and other territories became separate states.

Taimur.—In 1398 A.D. Taimur the Turkish conqueror invaded India and descending on Delhi took and pillaged this city as well as many other towns in the Punjab. Taimur, however, in the succeeding year left India for good and the rule of the Delhi kings was continued and under the Lodis considerably extended.

Babar.—In 1526 Babar, who in the fifth generation was descended from Taimur and who had taken Kabul and extended his rule over Kandahar, invaded India. The Lodi king was defeated at Panipat and Delhi occupied. In four months all the Delhi kingdom was reduced to submission and the Moghul Empire founded (1526—1803). In the reign of Babar's successor, Humayan, however, Sher Shah Sur obtained possession of the Empire and the Sur emperors ruled from 1540—55 until expelled on the return of Humayan who died shortly after but was succeeded by his son Akbar. In Akbar's reign the Empire was extended to the whole of North India (1594). Akbar then commenced conquests in the Deccan which were continued by his successor Jehangir. Under 200 years of strong government and conquest and increasing order and tranquillity the dominion of the Moghul Empire was in the year of Aurangzeb's reign (1658—1707) almost universal

throughout India. Later rapid decay set in and after the death of Aurangzeb the whole of Southern India became practically independent of Delhi.

The Mahrattas.—In the latter part of the reign of Aurangzeb the Mahrattas under Sivaji rose to power and under the Peshwa dynasty extended their dominion widely over the Deccan, the Konkan and Gujarat. In the Deccan proper the Nizam-ul-Mulk had founded an hereditary dynasty with Hyderabad for its capital which exercised nominal authority over the entire south. The Carnatic (eastern maritime plain) was ruled by a deputy of the Nizam known as the Nawab of Arcot. Further south Trichinopoly was the capital of a Hindu Raja; Tanjore formed another Hindu kingdom. Inland Mysore was growing into a third Hindu state. Everywhere local chieftains were in semi-independent possession of citadels or hill forts. These represented the deputies of the old kingdom of Vijayanagar and many of them had maintained virtual independence since its fall in 1565.

The French and British in India.—It was in this stage that in connection with trade to the East various European countries had established factories and settlements on the coast of India. Towards the end of the 17th century the French had factories at Surat on the West, Musulipatam and Pondicherry in the Carnatic and at Chandernagore in Bengal, the English at Surat, Madras and Calcutta. These settlements up to the time of Aurangzeb's death took no part in politics, but during the second half of the 18th century each power struggled with the aid of disputes between rival rulers of the different states for ascendancy throughout India. Under Dupleix the Governor of Pondicherry the French succeeded in placing a Nizam on the throne of Hyderabad and became powerful in the Deccan. To defray the expenses of troops kept in aid of the Nizam they were granted by him the Northern Circars. In 1759 Clive's defeat of the French at Condore, however, led to the transfer of this last mentioned territory to the British. In 1761 Pondicherry capitulated to

the British and though this was later returned French supremacy in Southern India then ceased. In Bengal defeat of the Nawab of Bengal by Clive at Plassey in 1757 and the policy of Warren Hastings similarly led eventually to British supremacy in Bengal. The various Mahratta, Mysore and other wars ending in the final overthrow of the Mahratta power in 1818, etc., consolidated British power in the peninsula and later the cession of Oudh, the results of the Burmese, Sind, Nepal, Sikh and other wars during the first half of the 19th century led to the present wide extension of the Indian Empire as it now exists.

III.

THE HISTORY OF MEDICINE IN INDIA.

Early Medical History.—The first "doctors" in the usually accepted sense in India were those that came with ships as Ships' Surgeons. In 1614 John Woodall was appointed Surgeon-General to the East India Company on a salary of £20 per annum. His duties (in London) were to see to the supply of competent surgeons to ships and the proper fitting out of their chests. His "surgeons" were apprentices trained by himself. He appears to have devoted considerable trouble to organising suitable medicine chests.

Almost as early one hears of a certain number of "medical men" from various sources in employment as physicians at the courts of Indian and other Eastern rulers. Many of these were French, also Dutch, Italian, Armenian, etc. Englishmen in this position were a later feature. There was an English surgeon in the service of Mahfus Khan, eldest son of the Nawab of Arcot, in 1748. Another served a later Nawab of Arcot to 1776. Two other Madras surgeons were in the employ of sons of the Nawab in 1778 and Nawab Mahomed Ali himself had 8 European medical men in his service, 2 physicians (Portugese) and 6 surgeons (English). In 1780 a Dr. Lloyd was in the service of Haider Ali during the time that he was fighting against the British and Dr. Lloyd was able to help the English prisoners taken by this ruler.

Many of these medical men in the courts of Native Princes had considerable influence. There is a legend which says that in 1636 a daughter of the Emperor Shah Jehan was severely burnt and that the services of a European surgeon were requested from Surat. The Council at Surat nominated Mr. Gabriel Boughton, surgeon of the ship *Hopewell,* who went to the

Emperor's camp, then in the Deccan. The Princess was cured and the Emperor in gratitude asked the Physician to name his reward which this honourable man did by asking for certain privileges for his countrymen in Bengal. It is not certain that the legend is true in all respects but it shows the kind of influence referred to.

The early English settlements were at Surat, Bombay, Madras and Calcutta. At each of these places medical men either resided for periods or were *en passant* in connection with ships. There were also branch settlements as at Broach, Ahmadabad, Agra, etc., and the services of medical men were required at these. The Company also had factories in Persia and in the Dutch East Indies, etc., and some amount of interchange of medical men took place. In the period 1668—1720 Crawford * gives 25 doctors who were surgeons in Bombay. In the Calcutta list are 10 names (1690—1728). A perusal of the lists shows that many of these spent but a short time in India, three or four years at most, but others remained 7 or 8 years or in a few cases up to double this time. In due course they returned home, were transferred or died. In this period William Hamilton, who accompanied the famous British Embassy from Calcutta to the Moghul Court at Delhi (1714) was able by his services to the Emperor greatly to help forward the objects of the Embassy, whose success was of very great importance to British interests.

The Indian Medical Service.—During the first half of the 18th century medical men, much as described above, were residing and passing through the settlements at Calcutta, Madras and Bombay. But in 1764 the Bengal Medical Service was founded and similar services for Madras and Bombay originated about the same time. By orders passed in the Fort William Cons. of 20th October, 1763, it was agreed that from 1st January, 1764, there should be a plan regularising the number, rank,

---

*** A very complete history from which these notes have been taken is given in Crawford, *A History of the Indian Medical Service*, 2 Vols. W. Thacker & Co., London, 1914.**

succession and appointment of medical officers. The plan arranged for 4 Head Surgeons to reside at Calcutta and 8 Surgeons of which the four eldest were to be stationed at the Factories of Patna, Cossimbazar, Chittagong and Dacca and the other four to be Surgeons of the Army and the whole of this rank to succeed in rotation to be Head Surgeons at Calcutta. There were also posts for 28 Surgeon's Mates who were to succeed in their seniority to be Surgeons. In 1774 a list of the Bengal Medical Service preserved in Calcutta gives 18 Surgeons including the Surgeon-General and Surgeon-Majors, 7 Subordinate Surgeons and 44 Assistant Surgeons. Under the stress of wars, etc., the number of the Bengal service as also the strengths of Madras and Bombay cadres were often considerably swollen by locally engaged men who usually came on in turn upon the sanctioned cadre. In 1854 the strength of the Bengal Medical Service was 382 (Administrative Officers 15, Surgeons 127, Assistant Surgeons 240). For Madras the total was 217 and for Bombay 181. At this time out of a total of 269 Surgeons and 511 Assistant Surgeons only 34 Surgeons and 138 Assistant Surgeons were in Civil Employ.

In 1766 the Medical Service was divided into Military and Civil. Both on this occasion and in 1796 this division was made complete, but it was on neither occasion found practical to maintain such separation. The position of the Indian Medical Service has since been made quite clear, viz., that Officers of the I.M.S. are primarily military officers, but that those in Civil Employ are temporarily lent for civil duty and form a reserve for the Army, being liable to recall for military duty at any time, as happened to the majority of such officers in the War. Officers now on joining the service serve in Military until, if they elect for Civil, a vacancy is open to them, when they may serve as Civil Surgeons, or join the Jail, Sanitary, Bacteriological or other branch on the civil cadre.

It seems strange at the present day to read that it was only relatively recently that general opinion did not suppose that it was Civil Employ, not Military, in which the greatest professional

opportunities were given. This arose from the fact that in those days there was little of the wide field of activity now undertaken by the Civil Branch. In the earlier times the Civil Surgeons' professional work consisted in attendance on a few Government Servants and that alone. Private practice was non-existent except in a few places and the only mofussil hospitals were Military Hospitals. Of hospitals or dispensaries for the general population there were none, nor presumably in these days had Sanitation and Public Health made any demands on the ordinary medical man. In the above manner was formed the Indian Medical Service which now for nearly two centuries has been the mainspring of advance in medical and sanitary science and organisation in India.

General Progress of Medicine.—Though we have spoken so far of "medical men" it must not be forgotten that medicine and surgery during much of the time we have been speaking of was still in a very crude and undeveloped state and very far from the later developed practice which arose as the result of the appearance of **Science** in the west. Science as we understand it was something which, strange and unique, came into being only very late in the history of the human race. It actually commenced in the latter part of the 17th century, but was not a recognised force until the 18th century. In fact though the early beginnings of science can be seen in these times it is scarcely an exaggeration to say that it is only within the last hundred years that Science, as it now stands triumphant, has appeared. The circulation of the blood was discovered in 1628. The earlier of the medical men we have referred to in India, even supposing that they were up-to-date in the "higher subtleties" of their profession, could not have known this, to us, simple fact.

In the time of Brown (1735—1788) the Brunonian "system" held sway in England, Germany, etc. It classified diseases as "sthenic" and "asthenic" and treatment as "stimulant" or "depletive." At this time also arose the strange

homœopathic "system." Up to now indeed medicine like many other subjects was in the pre-scientific stage and by its "systems", the result of as yet undeveloped accurate observation and experiment and of over elaboration of the supposed power of the human mind to think out things *ab initio*, probably lost more than it gained. It was only now that the very beginnings of Anatomy and Physiology and indeed of many sciences were being made. Asepsis, anæsthetics, a knowledge of the bacterial and protozoal causes of disease, and almost all we now call medicine and surgery arose in the second half of the 19th century. Only in the 19th century therefore can we expect to find in this story of medicine in India a reflex of the enormous changes that then took place as a result of the reaction of a newly risen Science on Medicine.

Hospitals.—A prosperous hospital at Goa seems to have been in existence before any hospital in British settlements. The first hospital in Madras was opened about 1664 and in Bombay in 1676. The earliest hospital in Calcutta dates from 1707-08. In 1784 there were 3 hospitals in Bombay one within the gates for Europeans (General Hospital), another on the Esplanade for Sepoys and a third for convalescents on an adjacent island. In 1824 a hospital was built in Hornby Road; it took the sick both of the Garrison and of the Civil population. St. George's was completed in 1892. The second hospital in Madras was built between 1679 and 1688 by public subscription at a cost of 838 pagodas or nearly Rs. 3,000. A third hospital cost 2,500 pagodas. In 1772 a hospital costing 42,000 pagodas was built. It was of two blocks perhaps the most westerly of those in the present General Hospital, Madras. Surgeon-General Gordon was the first to suggest the establishment of a hospital for the native population (1779); this became the Monegar Choultry. In 1816 a hospital for Lepers was completed which became the Madras Government Leper Hospital. On the proposal of Assistant Surgeon Conolly a Lunatic Asylum was built as early as 1794. The first hospital at Calcutta was destroyed at the capture of that City in 1756. There was a hospital for sepoys built in 1757 and a third hospital was built in 1770. All these were for the

Company's soldiers and sailors. The last of the abovementioned hospitals was replaced later by the Presidency European General Hospital. The Medical College Hospital had its first beginnings in 1838 when a small clinical hospital with 30 beds was built and an out-patient dispensary opened. An Eye Hospital was established in Calcutta in 1824 and a Lying-in Hospital in 1840 (later the Eden Hospital).

It was not until the beginning of the 19th century, that hospitals for the general population were established in some of the chief mofussil towns. A Public Letter from Calcutta, dated 1804, reports that the benefits of the Native Hospital in Calcutta have been fully realised; and that the Governors of the Hospital have been directed to communicate with the Senior Civil Servants at Dacca, Patna, Murshidabad and Benares with a view to opening similar hospitals in these towns. Some of the best known mofussil hospitals in Bengal were founded in the 'thirties, e.g., Muzaffarpur by Kenneth Mackinnon, Civil Surgeon of Tirhut and the Imambara Hospital at Hughli, which owes its origin to Thomas Wise, Civil Surgeon and Principal of Hughli College.

A large part in the creation of Hospitals has been played in India by Medical Missions. The first regular Medical Missions are said to be those founded and supported by the citizens of the United States in Southern India in 1830—40. In 1911 there were 332 medical missionaries serving in India and Ceylon.

It is in fact largely the result of men of outstanding professional attainments among the Civil Surgeons of the Indian Medical Service and Medical Missions that the mofussil hospitals and indirectly the numerous dispensaries throughout India have drawn for treatment the enormous numbers of the common people that they have done (about 40 millions are treated annually in some 3,634 Government Medical Institutions in the present day and another 8 millions in some 1,500 State Special, Railway and Private Hospitals). To a surgeon who has a name there flock the halt and blind and sick from far and wide and many

a hospital in India is but the ultimate effect of the professional skill and humanity of such a one.

Medical Education.—Some sort of instruction was given in the Hindu and Mahommedan indigenous systems early in the 19th century at the Sanskrit College and in the Madrassa. This was purely by lectures and reading and did not include dissection or practical work. The first real medical school in India was established in 1822 in Calcutta for training native doctors. Similar schools were started in Bombay in 1826 and in Madras in 1827, but after 6 years' running the Bombay school was abolished. Medical Education on a higher scale was initiated by Lord Bentinck in 1833. On the recommendations of the committee then appointed the Medcial College, Calcutta, was founded (1835). A medical school, the Madras Medical College, was started in Madras (1835) and another, the Grant Medical College, in Bombay (1845).

Since this time the number of Medical Schools in India has increased rapidly. Very often such schools have been the outcome of energetic and enthusiastic work by some individual Civil Surgeon or Mission Doctor or by the independent practitioner community, e.g., the Carmichael Medical College, Belgachia. The question has now come to be not so much the number of schools as the standards taught up to. These schools have produced not only numbers of men with Indian qualifications who largely staff the higher grades of the subordinate medical service, men often of great ability and attainments, but also the very useful and universally appreciated class of diploma holding Sub-Assistant Surgeons without whose loyal and ungrudging help the medical affairs of this country could not be run.

Advances in Medicine in India.—India can count many names preserved in the literature of medicine and surgery. Among the famous ones are Charaka, the pioneer physician, and Susruta, the pioneer surgeon, of early almost pre-historic times, taking rank with the great Hippocrates (460 B.C.). In more modern times are many Indian Medical Service Officers and

Mission Doctors and others who have added much to medicine and surgery making certain diseases and surgical conditions almost Indian specialities, among which may be mentioned the operative procedures for cataract and for stone-in-the-bladder.

In the more recent lines of Tropical Medicine and especially in Tropical Medical Research India has indeed a famous record. Among those whose fame is reflected upon her is the honoured guest of the Congress, Major Sir Ronald Ross, I.M.S., to whom is due the discovery of the mode of transmission of malaria, completely and for all time banishing the old ideas of miasma and opening up untold possibilities for the future. Also an honoured guest is Lieut.-Col. Sir Leonard Rogers, I.M.S., who has introduced or developed many new and important lines of treatment in tropical diseases. Among earlier names are Vandyke Carter, the discoverer of the first spirochæte, Lewis, the discoverer of the first trypanosome, Cunningham, who first saw Leishmania, and whose specific name for the parasite of Delhi Boil should still on the rules of scientific nomenclature hold good. Among others is to be mentioned Giles, one of the earliest mosquito workers and James the first, with Low, to see the final stage of the filarial embryo in the mosquito.

Advances in Sanitary Science.—In sanitation Indian workers came up against problems such as had no counterpart in their own country. In her early Sanitary Commissioners India had men who with little of the advantages of present scientific knowledge were still able to add much to that side of the study of disease that may most suitably be termed epidemiological. Later workers have also developed this field imposed on them by the vast magnitude of the disease problems of India. It was in India that malaria was first mapped by Dempster by use of the spleen rate. It was in India that almost all that is known of the epidemiology of bubonic plague was worked out. Problems in India such as no other country can present are still offered and are engaging attention. Formerly workers accustomed to India conditions failed to see very often that they were pitted

against things little known elsewhere—not only this but others outside India have often failed in such recognition. Progress in India may seem slow but the struggle has developed on special lines which may be expected in due course to yield appropriate results.

Women's Medical Service.—Lady doctors are a comparatively recent development. It was in connection with Medical Missions that they first made their appearance in India. The employment of medical women in India, however, received a great impetus from the foundation of the Lady Dufferin Fund. In the Lady Hardinge Medical College and Hospital is seen a great recent development of this side of medical work in India. In the active prosecution of Child and Maternity Welfare Work is seen another modern feature of Indian medical work. Formation of a Women's Medical Service is a step recently achieved.

IV.

INDIGENOUS SYSTEMS OF MEDICINE IN INDIA.

BY

THE HON'BLE MAJOR-GENERAL A. HOOTON, C.I.E., K.H.P., I.M.S.,

Director-General, Indian Medical Service.

AN eminent novelist has remarked that mankind everywhere has certain primitive cravings. Dancing, fighting, digging, religious ritual and rhythmical music are some of those he mentions. First aid and the administration of nostrums might well be added to these, and simple methods of treatment must have made their appearance very early in even most primitive societies. Beyond this, however, in the older civilisations, it is clear that shrewd observers have been at work from time immemorial, and one cannot live long in India without realising that her people who practise agriculture, and the primitive arts and crafts by means of which so many of them still gain their living, although they may be obsessed with various superstitions, often develop a vein of practical commonsense in the ordinary affairs of life which serves them well in injuries and disease. Thus, one is frequently struck by the acute observations and practical deductions of even ignorant country folk in medical matters. One cannot but admire, for instance, the sagacity which prompts a cultivator to apply a ligature above the injury in a case of snake-bite, although that may lead to disastrous results. It is sometimes necessary to amputate owing to gangrene from this procedure, and the tragedy may be accentuated by the reflection that the snake which inflicted the bite was probably harmless. Other instances of similar sound deductive reasoning, which do not involve undue risk,

are incision and mouth suction, applied by means of a brass funnel for the extraction of guinea-worm, as practised by an illiterate class of " shikaris " in the Deccan, and light splinting and early movement, as utilized apparently from remote times in Kathiawar by wrestlers, in the treatment of sprains and fractures incurred in the exercise of their hereditary profession. Some camel drivers, again, appear to have a very fair idea of the nature of volvulus. They say it is dangerous to drink large quantities of fluid before undertaking a journey on camel back, and in describing how the intestines of the rider are thrown about by the action of the animal, demonstrate the formation of a loop with consequent strangulation by the identical gesture that is so often employed in the lecture room. It would be interesting to know whether experience confirms that intestinal obstruction does ever result from camel riding, but these men, at all events, or their progenitors, have thought for themselves.

Apart from instances of this kind no doubt ordinary domestic medicine has been practised throughout the ages in India, as elsewhere, and Indian matrons were fortunate in having at their disposal some of the most useful remedies of the pharmacopœia long before they were available in Europe. The eastern peoples generally have also possessed for ages some admirable sanitary codes, which, if the spirit of them had been better observed, would have served as a considerable protection against the tropical diseases from which they so frequently suffer. The teachings of the old vedic scriptures, and the sanitary laws laid down by Manu and Moses, include many of the precepts of the modern science of hygiene, and would have furnished an excellent basis for further research, if, being holy writ, they had not unfortunately been regarded as definitive, and so sacred that to question or modify would have been impious.

As regards the regular systems of medicine which have grown up in India the position is somewhat confusing. The chief designations employed are Ayurvedic, Siddha, Yunani and Tibbi. There are many works available with regard to the first of these, and from the historical standpoint Ayurvedic medicine

is much the most important. The evidence seems to show that Siddha is merely an offshoot of this. Similarly, Tibbi is practically synonymous with Yunani, and there is no doubt that the latter, which was derived originally from the Greeks—partly directly, at the time of the invasion of northern India by Alexander, partly through intercourse with the Arabs—has borrowed extensively from the Ayurveda. The basic principles and details of practice are different, but many of the drugs employed are the same. The ancient Indian system is mentioned with respect by Greek authorities of that period, and it is evident that there was a mutual interchange of ideas, and that while the Greeks left their mark on Indian medicine by the introduction of the Yunani system, they themselves must have borrowed from the Ayurvedic system, which was undoubtedly at one time much in advance of their own.

There is thus, properly speaking, only one main indigenous system of medicine in India, and that is the Ayurvedic, which has impressed many of its characteristics on its chief rival, the Yunani system, and the brief space at our disposal will be most profitably occupied in studying the former. Like many ancient Indian institutions at the present time, both systems have passed their palmy days. The modern vaid and hakim (with rare exceptions) are no longer Sanscrit and Arabic scholars respectively, as they used to be, and it is probable that there are few localities in India where either system may now be seen to its best advantage, but the Ayurvedic system in some form still ministers to the medical needs of countless Hindus, and the Yunani to those of numerous Mahomedans. Ayurvedic literature is in the Sanscrit language, and Yunani mostly in Arabic or Urdu, and there is a very sharp division between the followers of the two, the vaids or Ayurvedic physicians, dealing with Hindus, and the hakims with Mahomedans. Finally, it must be mentioned that both classes of practitioner show a strong tendency at the present time to borrow from the precepts and practice, and also from the pharmacopœia, of modern scientific medicine.

Many volumes and articles have been published on Ayurvedic Medicine, and there is considerable difference of opinion as to chronology and other important details. The most that can be done here is to try to give some idea of the main features of the system and to attempt a fair estimate of its virtues and defects, accepting those theories which seem most probable where controversial points arise. Owing to extravagant claims which have been put forward by zealous protagonists of the Ayurveda, feeling has sometimes run rather high between them and exponents of modern scientific medicine, and there has been in some quarters a tendency to dismiss both it and the Yunani system with contempt. This attitude is to be deprecated. It is certain that 500 years ago both the Hindu and Mahomedan physicians of India must have been greatly superior in many respects to those of Europe. The names of Charaka and Sushruta may fairly be placed beside those of Hippocrates and the other famous Greek physicians, and in point of time they preceded them. The Ayurvedic school was the first to speculate on physiology and pathology, and, however, roughly, to investigate the structure of animal and human bodies, and so lead the way to the more accurate refinements of modern Anatomy. In remote ages they also began methodically to observe the signs and symptoms of disease. It has been remarked that there is a general tendency for orthodox Hindus to trace the beginnings of learning in all departments to revelation, and the Ayurveda is no exception. The oldest extant literature of Indian medicine is to be found in the Vedas—the ancient scriptures of the Hindus—which have been estimated to date back as far as 1500 B.C., and these are attributed to divine origin. It is the Atharvaveda, or fourth section of the Vedas, which deals chiefly with medical subjects, and as may be imagined for the most part the details are primitive and crude, consisting principally of demonology and spells and charms for the cure of certain of the more easily recognized diseases and injuries. An exception must, however, be made for the subject of Anatomy—particularly osteology—in which considerable progress had evidently been made at that time. It is

not, however, necessary to devote much attention to this stage of Hindu medicine, and we may pass on at once to the writings of Charaka, Sushruta and an author of a later date, Vaghbata, which, although based on the Vedic scriptures, mark a very distinct advance as compared with them. As regards dates, it may be assumed that Sushruta wrote some time in the sixth century B.C. He was primarily a surgeon and probably lived at Benares. Charaka is believed to have lived in Kashmir a century or two later, and was more of a physician than a surgeon. Vaghbata belongs to a later period, probably about the third century A.D. It is from these three writers that our knowledge of the present system of Ayurvedic medicine is chiefly drawn, and the most important of them is undoubtedly Sushruta, the earliest. All must have been much hampered by the assumed divine origin of the Vedas, from which they draw their main inspiration, and in view of that consideration it is remarkable that they made as much progress as they did. Had subsequent workers, in other subjects as well as medicine, used the same discretion, the history of science might easily have been very different, but authority was too potent for them, and the great scientific movements of the nineteenth century were destined to develop in the west.

The most noticeable advances, in the earliest times as has already been noted, were made in anatomy. The Vedic researches were mainly in the department of osteology, but in the time of Sushruta dissection, although of a very crude description, was resorted to. The method adopted by him was to macerate the body in a river for some days, and then to scrape with a sharp bamboo. In addition to this, however, observations were carried out by priests on the bodies of sacrificial animals—chiefly the goat, cow and horse—and descriptions of the bones and internal organs were recorded in the sacrificial literature, and no doubt added considerably to anatomical knowledge. But with such crude methods it is not surprising that arteries were confused with tendons and tendons with nerves, and that the connections of even the main organs were misunderstood. The rudimentary

science of physiology fared even worse. As one writer remarks, speculation and imagination were allowed full play. The ancient vaids knew nothing of the functions of the brain, of the spinal cord, the lungs, the heart, the liver, kidneys and spleen. They thought the heart was a reservoir for chyle, and the liver and spleen for blood. The heart was also the seat of breathing, mind and spirit, and of *oja,* an imaginary principle, supposed to be the supreme essence of the organism. Vedic anatomy and physiology, therefore, were of a very crude description, but when that is said, it has to be admitted that they furnished a foundation on which it was possible to make some progress in the arts of medicine and surgery. Here, naturally, speculation again came in to a considerable extent, and it was unfortunate that dogmatic theories were early laid down, which held the field for many centuries. The notion of the three humours no doubt originated with the three main seasonal variations, which in the north of India are abrupt and severe. *Vat* (wind) was responsible for ailments due to the rigours of winter, *pitta* (bile) was associated with heat, and diseases due to it were classed as bilious, and the rainy season group were called phlegmatic (*kapha,* phlegm). These ideas remained unchallenged through the ages, and not only the Vedic writings themselves, but the more advanced views of Sushruta which were partly founded on them, seem to have had all the authority of holy writ. Another formula was that of the seven proximal principles—chyle, blood, flesh, fat, bone, marrow and semen. With all this, however, it is noteworthy how much real pioneer work was done, and it is pleasing now to pass to the other side of the picture. The old Hindu physicians laid down some of the main principles of diagnosis. Inspection, palpation and auscultation were made use of, as well as taste and smell, and many of the main symptoms of the more obvious forms of disease were noted. The family history was also carefully considered. True, many of what are now recognised as general symptoms were classed as specific diseases, but that may well be forgiven, and there are many examples of shrewd and accurate observation. Sushruta, for instance, gave a recognisable

description of malaria, and even went so far as to attribute it to mosquitoes; diabetes is named "honey-urine" and the symptoms of thirst, foul breath and languor are noted. Inoculation against small-pox was apparently practised in Vedic times in India, as at the present day amongst the Persian hill tribes. Symptoms and diseases were grouped, and an elaborate system of nomenclature evolved, which, if it has had to be extensively altered in the light of modern knowledge, at least traced a path which that could follow.

In Ayurvedic therapeutics, again, there is evidence of much sound reasoning. For treatment diseases were divided into two main groups, sthenic and asthenic, and the practice adopted was logical from this standpoint. The sthenic group were dealt with by methods of depletion-purgatives and enemata, emetics, diaphoresis and blood-letting—while for the asthenic, stimulating treatment was employed. As regards drugs, those used in the days of Charaka and Sushruta were for the most part of a mild and non-poisonous type, with the exception of some severe cathartics. An enormous list of vegetable substances is detailed, and many of them could now, no doubt, fairly be consigned to oblivion, but they include a considerable number of drugs which have since been borrowed for the European pharmacopœias; for example, cinnamon, cardamoms, cannabis indica, hyoscyamus, nux vomica, jambul, kamala, senna and castor oil. Nearly all the present day forms of pharmaceutical preparations were employed—mixtures, pills, pastes, powders, ointments, suppositories, collyria and other lotions. Hygienic measures were also not forgotten, and elaborate dietetic and hygienic rules were laid down for a general regimen in health. Meals were to be taken twice a day, and foods and drinks were classified as "heating" and "cooling" respectively. Regular cleansing of the teeth was advised, and general bodily cleanliness inculcated. Clothing, exercise and rest, and massage also received attention. As regards dietetic treatment in disease, fasting is advised for certain conditions, milk diet for others, and sour milk treatment is also spoken of. It is noteworthy that salt is prohibited in dropsical

conditions. The researches of Brown-Sequard were also anticipated to a certain extent in the treatment of impotence by the administration of the semen and testicles of animals.

But it is in the realm of surgery that the most surprising originality and enterprise was displayed. Space is not available to enter into detail, and it must suffice here to note that apart from minor procedures such as the extraction of teeth and opening of abscesses, tumours were excised, puncture carried out for hydrocele and ascites, and lateral lithotomy and rhinoplasty performed. In the more special domains cataract was treated by couching, and Cæsarian section (after death) and embryotomy were carried out. Much ingenuity was displayed in fashioning surgical appliances, and Sushruta gives a lengthy list of instruments, many of which have their recognisable counterparts at the present day.

It remains to add that the Ayurveda was not behind-hand in laying down an ethical code for practitioners of medicine. Precepts comparable to those of Hippocrates are set forth, and with the last of these we may conclude "There is no end to the science of medicine. Hence heedfully and carefully devote thyself to it, considering it an hour to practise the art."

Enough has been said to show that remarkable advances were made by the ancient Indian physicians and surgeons, and that many centuries ago the foundations of medical science had been laid in this country, but unfortunately in this, as in many other departments of science, the eastern savants became bound by tradition, and the very extent of their progress proved their undoing. So far from advancing, knowledge actually retrogressed in the subsequent ages. The ancient vaid was a philosopher and scholar, and studied the ancient writings in the original. Here and there, no doubt, a worthy successor to him may be found, but Ayurvedic medicine is now largely in the hands of ignorant charlatans, and the same may be said, for the most part, of the Yunani system. There is at the present time, it must, however, be added, an attempt to revive both Ayurvedic and Yunani medicine, and schools have been established in various

centres for this purpose; but these institutions make no secret of the fact that they rely extensively on the modern scientific system and it is no longer maintained that the ancient systems can stand alone. A revival on these lines can hardly be considered sound. The ancient systems, however admirable in some respects, were developed, in the absence of a solid foundation of the basic sciences of physics, chemistry, anatomy and physiology, on purely speculative lines. They were based, like the old Chinese system, which until recently held sway in Japan, on fanciful theories which will no longer bear the light of day, and India would be well advised to follow the example of Japan, and while paying all due respect to her ancient pioneers, to adopt the theories and practice which modern science has placed at her disposal.

V.

MEDICAL AND SANITARY PROBLEMS OF INDIA.

BY

LIEUT.-COL. J. D. GRAHAM,

Public Health Commissioner with the Government of India.

1. General.—The evolutionary trend of modern medicine has all been in the direction of prevention, and, though a large and progressive organisation for medical relief is essential in every civilised country, the rôle of prevention is coming more and more to dominate the activities of all State services. To this end the direction of such State services is being vested more and more in the hands of public health experts who, in turn, form part of a ministry specially devoted to all phases of State health activity—the so-called Ministry of Health.

One by one the more enlightened of the nations in Europe and the Americas have, during the past 20 years, come into line by establishing such Ministries, and, in our own Empire, the example of the mother land is being followed by the Dominions, whilst recent developments at the Colonial Office are an earnest of a similar spirit in regard to our Colonies and Crown possessions. It is perhaps then a matter of surprise that a continent like India should be without such a Ministry, and no one who thinks ahead can envisage the existence for long of the present position. On the other hand it is necessary to recognise that India is passing through a difficult constitutional period which is about to be reviewed by a Royal Commission, and that in matters of this kind evolution is often slow. The introduction in 1922 of the reforms and of a very full measure of local autonomy in health matters has no doubt retarded the evolutionary process from the central point of view; and has at once introduced certain

difficulties and anomalies as between Central and Provincial authorities which will call for careful exploration when the Royal Statutory Commission is appointed; but, though many of these may be rectified by the alteration of the devolution rules, there will never be that co-ordination of policy and effort in public health matters which is essential for a continent like India, even with local public health autonomy, without the creation of something in the nature of a Ministry of Health.

Despite all that has been done by Western medicine in and for India—and it is not inconsiderable—most of us are conscious of many lacunæ, both in regard to special work untouched or problems unsolved. It will be our endeavour to point out our difficulties, and, with them, our main problems.

2. Constitutional Position—A Problem.—The introduction of the reforms already alluded to brought medicine and public health, under the Devolution rules, largely into the hands of the Provincial Governments. A reference to the wording of the pertinent Devolution rules which have been quoted in the footnote, will at once show the position of the Central Government.

Schedule I, Part I (Central subjects) paragraphs, 2, 8, 39 and 41 read as follows:—

> "Medical administration, including hospitals, dispensaries and asylums and provision for medical education, public health and sanitation and vital statistics subject to legislation by the Indian legislature in respect to infectious and contagious diseases to such extent as may be declared by any Act of the Indian legislature. Pilgrimages within British India, registration of births, deaths and marriages, adulteration of foodstuffs and other articles subject to legislation by Indian legislature as regards import and export trade. Ports except such as are classed as major ports. Regulation of medical and other professional qualifications and standards subject to legislation by the Indian legislature."

The wording of Schedule I, Part II (Provincial subjects), paragraphs 2, 3, 4, 22, 28, 30 and 45 is as follows:

> "External relations, including naturalisation and aliens, and pilgrimages beyond the seas; port quarantine in regard to any

It will be generally conceded that medical relief and public health in most of these aspects are able to develop more freely in an atmosphere of local autonomy as they have largely done in Great Britain; but, to make this as effective as possible, the Central Government should be able to exercise some measure of control in regard to the broad lines of policy. This they are not easily able to do at present. We constantly hear the cry for the necessity of introducing a Public Health Act for all India. Under present conditions this is impossible, though it is probably a very necessary measure. On the analogy of the effect of the great Public Health Act of 1858 in Great Britain we may be sure that a similar enactment for all India would go far towards stimulating the public health conscience in all the provinces. In other words in a country like India where ignorance, superstition and conservatism are rife, it may be regarded as the legitimate duty of the Central Government to give a wise lead by advice and suggestion without fear of being obstructed and without waiting to be asked. Ministries of Health do this, and, at the same time, by means of grants-in-aid, exercise a powerful leverage on all local authorities. In a country with nine provinces a wise advisory control exercised outside the limits of the present rules would not only raise standards, spread information, and co-ordinate work, but would guide development on a wide policy maturing over years and would eventually do more for the general public health than a series of independent spasmodic provincial efforts without any co-ordination or central stimulus. This is all an argument for a Ministry whose divisions would include medical relief, public health, maternity and child welfare, epidemics, research, international work and other activities. This is one of the biggest problems connected with the future and it

---

provincial subject, in so far as such subject is in Part II of Schedule I, stated to be subject to legislation by the Indian legislature and any powers relating to such subject reserved by legislation to the Governor-General in Council."

is to be hoped that it will be investigated by the Statutory Commission in relation to the Devolution rules. It deserves, however, an investigation to itself by a special Commission, as it is obvious to all who think, that the present position is one of makeshift, and is never likely to lead India on the big lines she ought to follow in public health.

3. State Services.—It has been frequently urged in the vernacular press and in argument that there is no further need for a Government medical service in India, the work being done under local arrangements. A reference to Sections III and VII will show what India owes to the various medical services which have for over two centuries supplied a body of highly trained and disciplined officers for civil work. It has become fashionable in some quarters to depreciate this debt; but impartial testimony will always recognise it. Our position in the country has necessitated a somewhat complicated system of medical organisation which could no doubt be simplified by unified control in a State service under a Ministry, despite the added difficulty of the British Army Medical Service. As the independent profession increases in numbers and in attainments more and more men will be able to take their places creditably in any auxiliary medical reserve; but, where so much is expected from the State, it would appear as if State services would have to be faced for a very long time. No doubt these will tend to centre round prevention in its various aspects, thus postulating again a Ministry of Health; and one would be content to leave it all to natural processes of evolution if the present position were satisfactory or at all reassuring. It is just the reverse. Those of us who entered the Indian Medical Service over 20 years ago realise only too clearly what is happening. From various causes recruitment of the old type of British medical officer has largely ceased. It is not enough to say that Indians can take their places. The British element in the services has set the tone of the profession in India and has done much through many generations to raise the standards throughout the whole country. Even though India can now produce men of the right type they are too few to exert all the influence required,

and the best of them recognise this. It is therefore essential that the best Europeans for many years to come should enter the State service, otherwise a debâcle may ensue and with it an awakening. In the interests of India and its peoples it is to be hoped that this may be averted by wise counsels. It is no argument that lower standards are equally acceptable to Indians and that declension or deterioration of standards is of little moment. This is not and never has been the tradition of the great medical State service of India, nor is it the tradition of British rule in India.

The introduction of Ayurvedic and Unani medicine into the picture has been, in the opinion of many of us, largely for purposes of political expediency, and the general attitude of the profession which has been trained on European lines is that the admixture of those with these is neither feasible nor practicable even if it were advisable or permissible according to Western medical ethical standards.

Briefly this problem is of the greatest moment in regard to India's medical future and requires to be handled in a statesmanlike way. Parrot cries and political expediency should be and would be eliminated if, on the right men, were placed the onus of decision. The essential aspects which must be recognised are, that India, apart from military needs, will require a State service even long after the Indian Medical Service as at present constituted has disappeared, that such a service if it is to carry on the traditions and standards of the past, must have, for a generation at least, an European element of the very best type that the British schools can provide, that Indianisation must proceed in an orderly way at not too great a pace and with due regard to efficiency apart from race, that the independent medical profession should recognise this by trying to develop more voluntary organisations, by opening new hospitals and avenues of work and relief. It is not too much to say that the independent profession has the future medical fate of India in its hands. It is untramelled by official restriction—a matter that is often forgotten—and is free to develop along good lines; but, in such development the individual

counts, and the high standards of a few leaders will influence the many who waver by the way.

The Public Services Commission reported as follows:—

"We are satisfied that in the present conditions of India, if there were no State service there would be large tracts of country which would be left without any regular provision of medical relief. We are also convinced that State control is necessary in order to secure the continued and extended diffusion in India of Western medical knowledge. We have no hesitation, therefore, in finding that a State service is needed and to this extent approve of existing arrangements."

4. Education.—(*a*) *Lay.*—Ignorance, superstition, conservatism, apathy, communal tension, and absence of a spirit of social service are all largely dependent on want of education. The percentage of the population who can read and write even in vernacular is only 8·2 per cent. despite the efforts and money expended. The corollary is an almost entire absence of public opinion, and, of public health conscience as we know these in the West. It is only in the largest cities that glimmerings of either are appearing, and, until they appear on a more convincing scale than at present, there would seem to be little hope of a big view being taken of the larger public health problems.

Endeavours have been made to explore the possibilities of teaching school hygiene. In August 1913 the United Provinces Government asked a * Committee on Educational Hygiene to report, and, in many other provinces, similar efforts have been made. The results are so far disappointing; but cinema development and general propaganda at health weeks are stimulating the younger minds. More should be done and could be done. Educating unhealthy unhygienic children is a proposition which is morally doubtful. Mr. Amery at the recent Colonial Conference said in regard to Africa that the question of native health was intimately linked with the problem of native education and that

* Report of the Committee of Educational Hygiene. Nainital, August, 1913.

they were endeavouring now to substitute for a purely literary education unsuitable to the natives, a type which, while conserving all the healthy elements in their own social lives, will also assist their growth and evolution on national lines, will help them to absorb new ideas and will make for building up character. It is for consideration if part of the purely educational grants could not be diverted into the channel of hygienic education or instruction suitable for teachers and pupils. It is a promising field and would lay a sound foundation for the future generation to build on.

(*b*) *Medical.*—The State services have been largely instrumental in creating the colleges and medical schools in India, and for organising the instruction and tests for several generations of Indians who have passed out by examinations. The effect of the reforms has been to remove the subject of medical education to the control of the respective provinces—surely an unwise procedure, when it is recognised how essential it is to keep up standards of education and examination if the requisite recognition is to be obtained. The process of rapid Indianisation is at work in many of the larger colleges and is leading to a great diminution of the European professorial staffs. The remaining British officers may be asked soon to do the impossible; already declension in some quarters threatens. The non-recognition by the General Medical Council of the teaching of one or two Universities in certain subjects is an indication that it is not yet finished. Though many excellent Indians have come forward, yet the process of rapid Indianisation of some of these colleges and schools is likely to be far from beneficial and to threaten a steady deterioration in standards. High standards are essential and every endeavour should be made to keep them high. The need for first class men only, be they British or Indian, is absolute. The further need to keep our college instruction pure and free in every way from the Ayurvedic and Unani systems is considered essential by most Western graduates. Better public health education is essential and is being arranged for in many provinces. We have long recognised that in many departments we

have much leeway to make up; but this is inevitable. The teaching of such subjects as pharmacology, physiology, bacteriology, fevers, maternity and children diseases, venereal disease and skin, ear, nose, throat, mental, x-rays and electro-therapeutics, public health, dentistry, applied anatomy, anæsthetics, tuberculosis, neurology, chemistry shows many deficiencies which we must try to fill in; whilst post-graduate work and fellowships are important.

5. Public Health Provincialisation.—The evolution of public health where it has been most progressive has always been on the lines of decentralisation of detail. On local authorities in Great Britain, whether municipal, parish or county council, has been placed the onus of working out the details of and applying the principles underlying the schemes and advice freely given them by the central authority, or of interpreting the method of application of the statutory obligations imposed on them by Government at the instance of the central health authority.

The recent reforms in India have followed on these lines, but, as already explained, have almost denuded the central authority of any serious power except as previously indicated. There are cogent reasons for reconsidering this position very carefully with a view, not to resuming central control over much that is obviously of provincial concern and that is in a fair way to being well administered, but to obtaining control over general lines of policy to the extent that will allow of a great basic frame-work for public health being accepted and worked to throughout the country. This would render possible the framing of a general Public Health Act, and of inter-provincial legislation on sound general principles. Such powers would eliminate the possibility of a demand by one province for special action on its own lines in regard to some particular problem which might affect its neighbours as well. Many instances of such difficulties have arisen since the reforms were introduced.

There are not wanting signs in various provinces that the basic administrative public health framework which Government has created over many years is imperfectly understood. Proposals to abolish Directors of Public Health, or Assistant Directors of

Public Health, or to reduce the establishment of subordinates such as the vaccination establishment are not unknown in quarters which ought to know better. Recent epidemic outbreaks, however, more especially cholera, have led to a free expression of opinion in the press on the folly of such advice and on the necessity for disregarding it. It is here that the power of the central health authority should be able to make itself felt as at present it cannot. Provincial health organisation would rapidly become chaotic without the administrative guidance which can only be supplied by specially trained men in certain numbers. It is, therefore, not only necessary to preserve the present organisation, but to better it by adding to it, and, for this purpose, sound public health training is necessary for all juniors, but especially for the staff from District Health Officers and Inspectors downwards. This must be met by better training in the colleges, schools and provincial public health institutes, one of which should exist in every province.

This leads up to another point—the provincialisation of the public health service. Health Officers, district or other, whose security of tenure is nil, are not going to show the initiative and independence that are necessary in such posts. The circumstances surrounding the social life of Indian Health Officers are such that independence of action is rendered difficult, and in some cases almost impossible; all the more reason, then, why such appointments should be put out of the reach of political or social intrigue. This is a matter which requires the early attention of several provincial Governments. If the intelligensia of the provinces would take the trouble to study the reports of the Directors of Public Health they would learn to appreciate better the way in which these Directors are able to estimate the provincial health pulse and to act in advance of danger.

The international and interprovincial aspects of the work of the Directors of Public Health can only be properly assayed by a central health authority which is thoroughly cognisant of all that is happening. Fortunately, despite the statutory obligations, the technical public heads of all provinces are only too willing to correspond informally and to give information centrally when

asked for it, thus enabling some accuracy of perspective of events to be obtained by the Central Government whose business it is to estimate the international and interprovincial implications.

We would urge the necessity for a large measure of local autonomy in health matters, and for the training in public health executive work which can only be got by the lay man on the health committee of a well organised municipality. If this sphere of activity were utilised as a training ground many men would be advancing themselves in the best duties of citizenship and preparing for work in a wider field.

Much has been written in administration reports regarding the shortcomings and neglect by municipal bodies of certain health aspects of their charge. Water works and a sound water policy have been neglected by more than one large municipality; and, in one province, the complaint has been, *not* that there was scarcity of funds, but "a certain deplorable attitude of mind which prevented proper attention being devoted to this subject of public health." It has been said of some bodies that their members lacked intelligent interest in public health problems and that they showed a reluctance to give State Health Officers either sufficient support or control to make their supervision effective.

It is well, however, to remember that some local authorities even in England are to-day remiss, ill-advised, and sometimes obstructive, so that we may hope this is a phase in India which will gradually improve.

6. Environmental Sanitation.—This is one of the biggest problems which India has to face. Ignorance, conservatism, absence of that spirit of social service and of public health opinion as well as of public opinion, have rendered it difficult in the past to break through the stone wall of obstruction which usually meets all State efforts in this direction. The low economic and social standards of life are responsible for much, as are also habits sanctified by centuries of religious traditions; but it is a truism that little good can come to the permanent residents of such hovels unless and until they are prepared to adopt certain fundamentals of cleanliness, order, and living in their respective

circles. Housing and village life generally, though on cheap and simple lines, need not necessarily be on principles so wrong that infectious disease is given every chance, that tuberculosis becomes rife, that hookworm becomes universal, and that cholera is endemic. Twenty years ago, in carrying out an enquiry in the Kumaon Terai, we learned to appreciate the superiority of the standards of housing and living as practised by these aborigines—the Taroos and Bukhsas—over the more civilised immigrants and other plains inhabitants. Their cattle lived apart, their houses were set singly in small compounds, their verandahs were deep and the houses were open to air perflation. The transition was so marked that it made an indelible impression, just as do those thousands of self-contained houses of the Malyali population in Málabar. These facts are worth pondering over; but the initiative in such matters must come from the people themselves, and preferably through their own national leaders. The state of rural India in this regard at the present moment is largely that of England a century ago. The real awakening has not taken place yet. Until it does it is idle to anticipate spectacular work in other fields which might claim our immediate attention in Western countries where this phase of so-called environmental hygiene has, generally speaking, been long since left behind. This field lies peculiarly open to the zeal of Municipal Health Committees and to voluntary effort of all kinds, and in this one feels there is the greatest amount of hope if development proceeds on lines like those of the co-operative anti-malarial movement in Bengal.

7. Disease Problems (epidemic, endemic, economic and social).—The problems created by the epidemicity and endemicity of such diseases as malaria, plague, cholera, small-pox, relapsing fever and kala-azar are probably the biggest and most important of those which we have to face. They are further complicated by the occasional visitation of epidemic influenza, and by the continued presence of such domestic and social diseases as tuberculosis, hookworm, filariasis, nutritional and venereal diseases, dysentery, leprosy, eye diseases and rabies. The

list is a formidable one and the different manifestations of most of the epidemic diseases occur on a collossal scale, without parallel anywhere in the world save in China. The 1908 epidemic of malaria passed over the North of India and caused quarter of a million deaths in three months; the influenza epidemic of 1918 killed at a low estimate over ten million people in that year; plague during the twenty years period 1898—1918 caused over ten million deaths; cholera in 1924 caused over quarter of a million deaths; small-pox in 1925 about 86,000 deaths; plague in 1924 over 360,000 deaths; while malaria in 1924 was probably responsible for over one million deaths. If one adds to these the huge unestimated morbidity one begins to form some true appreciation of the vastness of this disease problem.

Is it any wonder then that in 1925 with a birth rate of 33·65, a general death rate of 24·72 and an infantile death rate of 174·40 British India lost six million people; though the total population, despite this and owing to its great fertility, probably increased? The last census returns showed that in India there were at least 80,000 insane, 200,000 deaf-mutes, 500,000 totally blind, and 130,000 lepers—a hopeless underestimate (Dr. Muir places the number as nearer one million). In India the expectation of life at 5 is approximately 35 years and at 20 is about 27 as against 54 and 41 respectively in Great Britain. Generally it may be accepted that an India's expectation of life at birth is less than half the average figure for a European. The national economic waste due to all these can hardly be estimated. We can, however, agree that this tribute to disease must influence economic, political, financial and commercial considerations.

In considering these diseases "en masse" we get a clearer idea of this problem, the magnitude of which has been appreciated by past generations of State medical administrators, whose endeavours have been largely directed to tackling it by the best known methods with the machinery they have been able to create, and to bringing home to an apathetic and ignorant population in every way possible the necessity for an organised and intelligent method of attack on the part of the lay community

as well as by officials of the State. The difficulties surrounding this line of attack, which from time to time has had to come into collision with habits and customs sanctified by tradition, convention and often by religion, need only be alluded to to be adequately appreciated. After several generations of general education and of organised medical effort some improvement, some advance, and more intelligence in the larger centres of population are discernible; but those of us who have watched the drama and the stage setting during the last 25 to 30 years are disappointed at the slow rate of progress, though we may still be hopeful for the future. More rapid communication and dissemination of news, especially of the outer world, more intercourse with Europe, America, and the Dominions, the example of the modern evolution of Japan, the story of the health advances of other tropical countries, the extension of political responsibility are all tending towards a growing awakening of intelligent interest in these problems. This is being reflected in some provinces such as Bengal by a large development of voluntary effort in the form of societies for combating malaria, kala-azar, water hyacinth, etc. This is a reassuring sign and augurs well for the future.

The future solution is intimately bound up with the provincial public health organisations which are best able to spread the modern gospel of "prevention," and whose cadres should be kept as strong and efficient as possible.

Research in regard to all these diseases mentioned has been a feature of western medical evolution in India, and our record in regard to it is one of which we can justly be proud. Its story is told in another chapter. The work still continues; but the application of its results is a rôle which must be played by the various lay communities under expert guidance, and it is part of an enlightened provincial health policy to ensure that those responsible for allocating public money should appreciate adequately the importance of the problems referred to.

It is gratifying to be able to record that such signs are not wanting throughout the provinces despite the echoes of ill-informed

criticism. The most thoughtful Indians are beginning to realise that they must be up and doing if they wish to bring their country into line with others no more favourably situated. Many see the standing object-lesson in India of the British and Indian Armies and European communities, whose hygienic conditions of life make for a huge reduction in mortality though climatic conditions are similar to those of the general population; they realise the advantages of pure water supplies and of better housing. It should be part of the aim of more enlightened to spread by every means possible the information regarding these, and, especially in rural areas, to show villagers by example what to avoid.

The practical application of the results of our researches in malaria, plague, cholera, smallpox, kala-azar, hookworm and rabies is being pressed forward in various ways which will be demonstrated during this visit; but work on nutritional diseases and filariasis, and more organisation in regard to venereal diseases and tuberculosis are urgently required in certain areas. A central and many provincial organisations for malaria are focussing expert attention on specific problems; application of our latest ideas in regard to plague prevention is receiving the closest attention especially in the Punjab; cholera endemicity research and prevention in Bengal, Bihar and Orissa, United Provinces and Madras is in the hands of several expert workers whose work is being closely followed internationally; 10,000,000 primary vaccinations per annum with eight lymph depôts able to supply all that is necessary for complete protection of the population; over 30,000 rabid bites treated annually in and from six institutes; a hookworm survey of India and a campaign against it in Madras; a wonderfully effective campaign against kala-azar in Assam at a cost of over rupees 16 lakhs and of which the Government of Assam has every reason to be proud; all these go to show that the problems are not only appreciated but are being tackled. Much ground still requires to be broken, and this will provide a field for the best efforts of medical India for years to come. It is only by thinking out sound practical

schemes of attack. by getting them financed and by applying them, that the rising generation of Indian public health workers, both medical and lay, will make good their claims to the positions they wish to hold, and will adequately do their duty by their country, and incidentally, by other nations who look on India as the great reservoir of certain infections for the rest of the world.

We have endeavoured to show what is being done; but we must consider the other side of the picture. Many gaps in our knowledge still remain, some of which have been pointed out from time to time by prominent workers in the sphere of tropical diseases. We shall indicate a few which require attention.

(*a*) Acclimatisation and its various problems, the result largely of temperature and altitude, with their relation to clothing, to neurasthenia, to insolation.

(*b*) Mosquito-borne diseases such as malaria, dengue, filariasis. Malaria still affords us many problems some of which have been elaborated by Hegner of Baltimore and by Stephens. * The nature of the toxin, and of black-water fever, the period of infectivity of an infected mosquito, the method by which the parasite attacks the red blood corpuscles, the precise action of quinine and stovarsol on different varieties of parasite, a more precise method of diagnosing latent malaria all demand attention.

(*c*) Various gaps occur in our knowledge of Tick typhus, of relapsing fever (life-cycle of the spirillum), of leishmaniasis, and of plague.

(*d*) The value of D'Herelle's bacteriophage in dysentery, cholera and plague.

(*e*) The value of bacteriological analysis of drinking water in the tropics.

(*f*) Sprue and dysentery. More work is needed on the therapeutic value of the serum, of emetin, of stovarsol, of yatren;

---

* Some Tropical Lacunæ. Balfour, 1927.

on the "carrier" state; on the diagnostic value of the serum reactions in the bacillary type.

(*g*) Nutritional diseases.

Our Indian Research Fund Association and Research Department are focussing their attention on many of these lines of work; but more expert workers are needed.

8. Medical Relief and its Extension.—In paragraph 3 we have quoted the opinion of the Public Services Commission of 1916 in regard to the rôle of the State medical service in this respect.

It is now generally recognised, however, that the extent of modern medical relief afforded by our present medical organisation is lamentably deficient, and that it is well-nigh financially prohibitive for any province to embark on a State supply of this to all the rural areas of India. We have endeavoured to show that there may be ways and means of doing this without resort to the retrograde policy of bolstering up the ancient systems with their defects.

It has been calculated recently that in Bengal, with nearly 3,927 registered doctors to a population of 46 millions, the proportion was 1 to 11,450 persons.

Fortunately the different local Governments are studying the problem carefully, and schemes are in preparation to cope with this problem on different lines. First we have the work of our Red Cross Society, of the St. John Ambulance, and of the Indian Council of the British Empire Leprosy Relief Association. There are schemes for the development of medical aid for women and children; there is in Bengal a scheme known as the Public Health Organisation scheme of the late Mr. C. R. Das estimated to cost about 18 lakhs (£135,000). In the Punjab we have a scheme to add 375 new dispensaries to the 666 hospitals and dispensaries now existing in the Province, thus ensuring medical relief in each ten-square-mile area; and to add to the institutions and personnel for women's hospitals. We have in Bombay a scheme for training rural teachers in the principles of first aid and simple medical relief and for utilising this knowledge

by placing them in villages of about 1,000 inhabitants; while in the United Provinces the Minister for Self-Government recently convened a public health conference and considered ways and means for the improvement of rural sanitation and for carrying on health propaganda more intensively.

The idea of subsidising private practitioners to settle in country districts is not a new one; it has been tried in some of the Colonies. It presents the same difficulties in almost every country—the desire to herd and to get rich quickly. It is hoped that the experiment now begun will receive the support of the younger graduates, who in turn should be supported by the zemindars. It would also act by relieving the cities of the existing medical congestion, and by developing a really independent profession. It is one solution of a large part of this problem and would open the way to less dependence on the State, for this aspect of "State aid" is one which is imperfectly realised in India. Government of India is almost the only Government which arranges for medical and surgical relief for the general population, and educates almost the entire local medical profession on the lines of a Western medical curriculum.

9. Research and its Application.—India has had the good fortune to have the services of a band of brilliant workers who formed the Bacteriological Department over twenty years ago, and who have directed and participated in all branches of medical research work since then. The story is told in another Chapter; but, in view of the position which medical research has occupied at the recent Imperial and Colonial Conferences, it is necessary to make some remarks on certain aspects of its future which may be classed as problems.

Its present organisation and its co-ordination in India have followed well-established lines, and, in the absence of a whole-time Director of Medical Research, the part that the Public Health Commissioner has undertaken in this work under the Director-General, Indian Medical Service, has not been without its advantages to the Department as it has helped materially to

co-ordinate the public health with the research aspect of the work. These should be closely identified, as it is only by such close co-operation that the results of research can be easily made available to the public health authorities for practical application. Many of us have been inclined to deplore the way in which the application of the results seem to have lagged behind their discovery, and perhaps this is a side the difficulties of which, both financial and administrative, are not adequately appreciated by the pure research worker. Our co-ordination through our Conferences has to some extent helped to meet this difficulty, but not entirely. It is here that the Director of Public Health is of value to his Government by being able to present to them the facts and their implications. No one is in a better position to do it. We would, therefore, plead for closer co-operation here.

Schemes for better co-ordination of our research work, more especially with research work outside of India, will no doubt soon be forthcoming in view of the increased interest fostered by the recent Conferences in London. When they appear we shall be prepared, if necessary, to alter or add to our existing organisation if it is to be for the good of medical research generally.

The chief remaining problem, apart from that of adequate financial support, is that of recruitment. Retirement of outstanding men and recent inability to recruit the best type for such work is making us regard the future anxiously. There can be no question of filling up such cadre appointments with mediocrities, as, with such a system, the Department would soon cease to be a research department and research would languish. The most rigid selection, irrespective of racial consideration, is the only solution which we should recognise. Indianisation to a fixed proportion and at a particular pace will, in the present state of Indian recruitment, spell disaster. It is essential to recognise the fact that other qualifications than those of possessing examination degrees, or of having studied in Europe or America are essential for the successful research worker, and often these can only be discovered by a period of probation.

The fact that an expert Committee is about to assemble, with very wide terms of reference in regard to research organisation in India, is an earnest that Government is alive to the various problems in this Department.

10. Registration of Vital Statistics.—"There is no organised health staff for more than 90 per cent. of the population; only an insignificant percentage of the people who die annually are seen at any stage of their final illness by persons possessing any sort of medical qualification; the actual recording of vital statistics nearly everywhere in rural India is in the hands of a staff who may have some claim to literacy, but certainly no other qualification. Unless the fallacies are carefully kept in mind one is tempted to draw more deductions than the figures warrant." (Quotation from the report of the Public Health Commissioner with the Government of India, 1919.)

This is still largely true, and it is a problem the future solution of which is one beset with the greatest difficulty, as it must always be in any country with a huge indigenous and illiterate population. The Births, Deaths and Marriages Registration Act of 1886 provides for voluntary registration of certain births and deaths, for the establishment of General Registry Offices, etc., and applies to British India and to British subjects resident in Indian States. It does not preclude the adoption of local registration measures where such have been instituted or are desired. Deaths are notified by relatives, by anyone present at death, by anyone in the same house who knows of it, by anyone viewing the body after decease. Local Governments make it applicable in certain areas; but it is obvious that, when an illiterate population of 300 millions is considered, it is only in the large municipalities that anything approaching modern western ideas of registration is or can be carried out. Absence of doctors trained according to western methods precludes any attempt at registration on western lines outside the larger cities and towns. In the municipalities not only is registration urged, but medical certificates of deaths are recorded where possible.

In the country the onus is usually placed on the village headman or chaukidar, who reports and shows his book to the nearest police station at regular intervals, and whose entries, though fairly correct in regard to totals, are inaccurate as regards causes. Such pitfalls and inaccuracies have long been known to the authorities; but it is difficult to prescribe a remedy. The chain of reporting as it exists in the various provinces need not be described in detail. Though it varies in different areas the one similarity is that the chain is largely non-medical and proximate causes of death are as reported by lay men. We may, therefore, regard this system of registration, which has existed for over half a century, as being capable of furnishing crude rates which are only approximately correct, but which can yield much information to the expert statistician who knows local conditions.

No practical scheme for improving these figures exists, and it would appear that any improvement can only come in time with the spread of education, western medicine, enlightened public opinion and district public health organisation, with a rise in the economc standards of the country and some appreciation of the value and possibilities of disease prevention.

11. Maternity and Child Welfare.—Thousands of women are sacrificed every year to the gross ignorance and incompetence of the Indian *dai.* The infantile mortality rate for all India in 1925 was 174·40 (188·66 in 1924); in Poona city it rose to 611, and in Cawnpore to 420. What the Countess of Dufferin's Fund, the Women's Medical Service, and the Lady Missionaries have done to combat this has been outlined in another section. It is one of India's biggest tasks and is now being attacked from many different angles, e.g., by District Health Schemes, research propaganda, general hygienic education. National Health and Baby Week Celebrations, education of *dais,* training of midwives, extension of female medical relief and education, and institution of health schools. Much remains to be done; and not the least part of this problem is the difficulty which is experienced in getting the right type of women to come forward

and train, and in getting *dais* to abandon their old habits. The developments, however, are full of hope. It is very regrettable that the Indian community has, in the past, been so supine and lackadaisical over this great blot on its social life. Recent writings from an independent and unbiassed source have shown up the magnitude of the problem in all its nakedness. More co-operation has been suggested between civil and mission hospitals and between the independent profession and the people so that more hospitals and medical schools may be created independently of the State.

12. Ayurvedic and Unani Problem.—The chapter devoted to these systems must lead us to the conclusion that the line of true medical progress for India does not consist in their resuscitation with all their defects; but, in the absorption into modern medicine of anything worth which they may possess. The pharmacologcal work on indigenous drugs now being carried out in the Calcutta Tropical School and in the Haffkine Institute, Bombay, is an earnest of our desire to do this in the most scientific way possible.

So-called "Western" medicine is a lineal descendant of the old Unani system which formed the basis of the European medical system of the middle ages. The world's opinion is that modern scientific medicine and surgery are superior to these and to all others. Japan, whose attitude to western medicine a few years ago was one of open hostility and obstruction, has now declared whole-heartedly for it in all its branches, and in providing scientists and workers of international reputation. It would be a very retrograde step for any modern State to go back to the unscientific systems which could only be revived by trying to assimilate modern science, when they would at once cease to be what they called themselves. Many thinking Indians are of this opinion, knowing as they do the empirical methods of these systems and their dangers.

It is believed that much of the recent cry for their revival at State expense has been a political one. This aspect is one

which must be combated, as it is only on merits that modern medicine and surgery are and should be judged to be the best.

The attempt to associate a revival of the ancient systems with any institution (school or college) which teaches modern medical science and art is one to be deplored. It has been advanced that modern medicine is too expensive to allow of the expansion of medical relief now necessary for the country; but there are other ways of meeting this difficulty, and it is gratifying to see that several Governments are trying schemes which will obviate the necessity for abandoning what, after all, is a much more advanced and progressive practice of the art of medicine and surgery.

The continuous agitation for State recognition of these systems, be it political in origin or otherwise, presents a problem regarding which all who understand the history of medicine, be they European, American, or Asiatic, can have only one opinion.

13. International and Port Problems.—Since the termination of the Great War overseas commerce has gradually recovered, and, with its recovery, has focussed international attention on those ports throughout the world which might aptly be called reservoirs of infectious disease. Unfortunately India is the chief offender, as her major ports are seldom free from either plague, cholera or small-pox.

The devolution of certain aspects of port work has not absolved the Central Government from responsibilities in regard to others, and, with the revision in Paris in 1926 of the International Sanitary Convention, the anticipated ratification of it will compel attention to certain aspects of port development which are required by the Convention. The problem will be to arrange for these improvements and for central control with such co-ordination of public health and medical effort locally as will make for the minimum of friction with the maximum of efficiency.

Recent developments of medical epidemiological intelligence, mainly through the Bureaux of the League of Nations, are now

bringing home to the rest of the world what the disease state of our large ports is. A very definite effort will, therefore, have to be made to make them conform to the highest public health standards.

Our industrial conditions will in time come under review, probably by the Labour Organisation of the League of Nations, and the question of industrial hygiene will require to be faced and some of its modern principles accepted.

14. Voluntary Agencies.—In India we are at the beginning of the way in voluntary effort, largely because of the established principle of State-aided medical relief everywhere. A glance at this aspect of medical work in Great Britain will convince the most sceptical of the value of such societies and of such workers in the cause of health. Our greatest reform such as the Poor Law Reform, Burial Acts, early Housing Acts, Midwives Act, etc., had their origin in voluntary effort and the work of great laymen like Chadwick can never be forgotten. The ordinary individual cannot be controlled in his habits and personal health by Acts; and people require to be told how to interpret and apply much that a State system of sanitation and public health provides for them. The result is apparent in 20 to 30 different voluntary agencies now at work in Great Britain. Unfortunately this aspect of public work has been largely conspicuous by its absence in India; but the recent developments of the Seva Samiti and other kindred societies for social service are paving the way. Further effort is needed, and every encouragement should be extended towards the work now being done in Bengal by co-operative anti-malarial and anti-kala-azar societies. This is a problem which is largely a layman's and which might obtain the blessing of the Department for Local Self-Government in every province. Much that will repay perusal has been written on this in other countries by some of our wisest sanitarians; but the spirit of service and sacrifice must be developed in the country's youth before it will bring forth abundantly. In this there is a wonderful field for real

endeavour for young India, for, be it remembered, that, though the tendency for the individual of whatever race is to have a distinctly provincial outlook, disease is no respecter of geographical, political or ethnographical boundaries.

Even if preventive medicine in India is no further advanced now than it was in Great Britain in the seventies, our Indian members of the Legislative Assembly should realise their responsibilities in regard to it not only to their own country but internationally.

15. Population.—At the census of 1872 the population of British India was 180,508,677; at that of 1925 it was 241,469,026. With high birth, death and infant mortality rates it has been estimated that the difference between the birth and death rates was at a normal of 7 or 8 per cent. in a decade. The steady increase, despite epidemics and famines, is significant, and may in time lead to a problem of the first magnitude. It has been examined provincially by workers in different provinces. The Director of Public Health, Madras, considers that the population of Madras Presidency is now near its asymptotic maximum, and, if it rises much higher, will come down by "violent epidemics or famines." The same begins to hold good of other provinces. This problem requires study independently of the decennial census report.

16. Public Health Policy.—We have enumerated a few of the more urgent medical problems in India to-day, but should like to conclude by drawing attention to one problem which is always with us—that of "indifference" or the "laissez faire" attitude so dear to many. In this connection arguments have been advanced for curtailing or minimising effort—such arguments as over-population, interference with religious customs and fixed habits, want of conviction of the value of our measures. These should never allow us to deviate from the path of continuous sanitary reform and improvement as the general principles underlying such reform and improvement do not change. The development of a rural health organisation commensurate with

the importance of the issues involved is one main way of effecting this primary reform. Even though India's health problems are of greater magnitude than those of almost any other part of the civilised world, and the sanitary reformer's path is one strewn with obstacles due to causes already enumerated, we can point to great sanitary improvements in the country during our time and can attest to a widespread awakening within recent years. Through State medical service help this tender plant has taken root, and, if it be carefully tended by the great Indian medical profession, then it should grow and eventually give every promise for the future.

VI.

MEDICAL AND RESEARCH ORGANISATION.

BY

LIEUT.-COL. J. D. GRAHAM, C.I.E., I.M.S.,

Public Health Commissioner with the Government of India.

A. MEDICAL ORGANISATION.

1. General.—No account of the present medical organisation in India could be regarded as complete without some historical reference to its evolution since European civilisation and culture first touched India's shores over 400 years ago. As many of the early records are preserved it is proposed therefore to allude, though very briefly, to this aspect. Moreover, much of the story has been enshrined in the two excellent volumes of the * History of the Indian Medical Service by Crawford; and to this work we would direct the attention of all who desire more details. Much of this will doubtless be dealt with in the Chapter on the "History of Medicine"; but a few of the salient points will bear repetition.

2. Historical.—The development of so-called western medicine in India is primarily identified with the medical service of the Hon'ble the East India Company and later with the State service, the evolution of both of which may therefore be dealt with in some detail. From 1600—the date when Queen Elizabeth granted the Charter to the Hon'ble the East India Company—a regular service of "Indiamen" as distinct from expeditions,

* A History of the Indian Medical Service, 1600—1913, by Lieutenant-Colonel D. G. Crawford, I.M.S. (Retd.). Two volumes. Thacker & Co., 1914.

began to reach these shores. During the voyage round the Cape under sail they were exposed to difficulties from weather, from want of good water and fresh provisions, from outbreaks of disease, and from the fortunes of war all of which necessitated medical help on board. Many ships carried more than one Surgeon, and, at a period when time seemed to be of little moment, Surgeons, when able to be spared, were put ashore at the various factories for varying terms. These men, who formed the vanguard of the profession and were in reality factory or civil surgeons, became engaged in civil practices, and many of them were of the utmost value politically to the Company. As early as 1614 the Company possessed in London one Surgeon-General (John Woodall) who supervised the selection of personnel and equipment for the East. In view of the political conditions from 1600 onwards India came to possess many European surgeons, some of whom like Bernier, Manucci, Martin, Bazin, Castro were of French, Dutch or Italian extraction. Others of British extraction like Gabriel Boughton, William Hamilton, John Holwell and W. Fullerton made a permanent niche for themselves in the history of India by their political, medical or literary work. In this connection one may be pardoned for quoting the epitaph which appears in English and Persian on the tomb (still preserved) of one of these—Dr. William Hamilton—who died in Calcutta on 4th December, 1717, two weeks after his return with the Embassy from the Court of Delhi.

"Under this stone lies here interred the body of William Hamilton, Surgeon, who departed this life the 4th December, 1717. His memory ought to be dear to this nation for the credit he gained ye English in curing Farrukseer, the present King of Indoostan of a malignant distemper by which he made his own name famous at the court of that great Monarch; and without doubt will perpetuate his memory as well in Great Britain as all other nations in Europe."

As we work through the centuries we pass in review many names of famous doctors whose claims to fame centre largely round the scene of their labours—the factories at Surat, Bombay,

Calcutta and Madras; but many passed beyond these spheres, for, with a continuous series of campaigns and an advancing frontier, numbers adopted a military career though in the service of the Company. Thus from 1766 onwards our medical personnel from Europe came to be divided into a military and a civil branch, men no doubt being interchangeable as ability and circumstances dictated. From this eventually arose the accepted position that the officers of the Indian Medical Service are all primarily military officers, that those in civil employ are only temporarily lent for civil duty, in which they form a reserve for the Army, and that they are liable to recall to military duty at any time. Furthermore, there developed from this a very early organisation for the training of subordinate staff as dressers, apothecaries and general hospital helpers—the forerunner of the highly trained subordinate services of later times.

In 1763 the Bengal Medical Service was founded by an order which fixed the medical establishment at 40; by 1790 that for the Indian Army on a peace footing was 234, with 100 Assistants—so-called Assistant Surgeons—for both civil and military. Since then complete authentic records show the position and its development from time to time in all three Presidencies of Madras, Bombay and Bengal. The table given overpage shows the position in the three Presidencies in 1861 and in 1913—the date on which the officers of the Indian Medical Service ceased to be borne on Presidency lists and were shown on one general list.

As the service evolved and as peace conditions became more established, the surplus military personnel was gradually freed for civil work of the most varied kinds, thus absorbing the so-called "war reserve." This has remained a feature of the Indian Medical Service ever since. It proved an economical arrangement to all parties, it enabled the keen men to build up through many generations a huge civil medical fabric of medical relief in hospitals, dispensaries, jails, asylums, of medical education, and of sanitation, whilst it allowed selected officers from this "scientific" corps to be utilised in organising many other activities such as chemical examiners' work, botanical,

zoological, and marine survey work, work in the Opium Department and in the Mint. In those early days the Indian Medical Service shared with the Royal Engineers the distinction of being one of the two organised scientific corps in India. Once this story of evolution is grasped much which the Indian Medical Service has done or been asked to do in India becomes intelligible.

Date.	Rank.	Bengal.	Madras.	Bombay.	*I.M.S general list.	Total.
July 1861 (post Mutiny)	Administrative Medical Officers	15	10	8	..	33
	Surgeons	125	66	48	..	239
	Asst. Surgeons	264	143	140	..	547
		404	219	196	..	819
January 1913.	Administrative Medical Officers	11	5	4	..	20
	Lieut.-Cols.	83	20	23	..	126
	Majors	58	29	13	131	231
	Captains	..	..	..	324	324
	Lieutenants	..	..	..	69	69
		152	54	40	524	770

* After 1913 all officers came on a General List.

It was only a step from this position to that when military service became obligatory for two years after which an officer could apply for "civil," and, once installed in it, could remain there for the rest of his service barring military emergency, which, until the great war, never usually affected men in civil employ after ten years' service.

To further complicate matters "medical" the introduction of a permanent garrison of British Troops (Imperial Army) into India brought with it the medical organisation of the Imperial Army—the Royal Army Medical Corps (R. A. M. C.)—who not only controlled the health and medical relief of those British

Troops in Cantonments and Station Hospitals throughout India, but also demanded in time the creation of a service of subordinates—the Military Assistant Surgeons—to assist them. The division of work naturally arrived at was:—

British Army R. A. M. C. Officers and Indian Medical Department (Military Assistant Surgeons).

Indian Army I. M. S. Officers and Indian Medical Department (Military Sub-Assistant Surgeons).

3. Present Composition of the Profession.—After this historical resumé we are now in a position to consider the present heterogeneous composition of the medical profession in India. It divides itself into three main groups:—

(1) The State medical services.
(2) The independent medical profession.
(3) The followers of the ancient systems of Ayurvedic and Unani.

It will be evident how No. (1) and No. (2) have developed and forced themselves on a country given over to No. (3). Let us look briefly at the composition of these three groups:—

(1) *The State medical services.*—These are the R. A. M. C. and I. M. S.—both being military, but the latter having its war reserve absorbed by civil, whilst the purely military element ministers to Indian Troops as the R. A. M. C. does to British Troops, under the guidance of the Director of Medical Services in India, who is a Major-General of either Service alternatively and the adviser of the Commander-in-Chief in India on medical and sanitary matters. Ten of the administrative army appointments are held by R. A. M. C. (Army Medical Service) officers, and 10 by I. M. S. That 47 per cent. of the I. M. S. which is in civil is controlled by the Director-General, Indian Medical Service, who is also Surgeon-General with the Government of India. Its cadre is diverted into various channels, the chief one being that under the Provincial Medical Services and consisting of the Civil Surgeons and most of the professional appointments at the Colleges and Schools. These officers are provincially

administered by the three Surgeon-Generals in Bengal, Madras and Bombay and by the Inspectors-General of Civil Hospitals in the other provinces, who also control the other provincial personnel, and the Civil Assistant Surgeons and Sub-Assistant Surgeons, who are purely provincial servants. There are also specialists such as chemists, bacteriologists, and public health officers. Briefly, these State medical services discharge, on the military side, all the administrative and executive medical and sanitary work of the whole army, on the civil side, the administrative and executive work of all Government hospitals and dispensaries, jails, asylums, leper homes, medico-legal work, medical relief to officials, medical education, and general public health measures in India. In the tabular statement appended will be seen the present strength of these services.

		I.M.S.			I.M D.		Civil (Provincial).	
	R.A.M.C.	in military.	in civil.	Total.	Assist. Surgeons.	Sub-assistant Surgeons.	Assist. Surgeons.	Sub-assistant Surgeons.
Numbers on Indian establishment ..	284	404	362	766	613	880	992	3,849

(2) *Independent medical profession.*—Apart from the large numbers of European private, railway, Mission and planter doctors there is the great independent profession, mostly Indian, and composed of men with or without European qualifications. A certain number of independent qualified women, European and Indian, also practise now.

(3) *Followers of Ayurveda and Unani.*—The numbers are unknown; but "their name is legion" as they include charlatans of every description, as well as genuine Kavirajs or Vaids for the Ayurvedic and Hakims for the Unani systems. The Ayurvedic is the ancient Hindu system; the Unani or Tibbi is the Grecco-Arabic system on which much of the European practice till the

middle ages was based. These have been discussed in another chapter.

Let us look at these divisions in further detail in the following order:—

(1) *State medical services in general.*

(2) *Military medical services.*

(*a*) R. A. M. C. and I. M. S. (military).

(*b*) Subordinate medical services (Indian Medical Department).

(*i*) Military Assistant Surgeons.

(*ii*) „ Sub-Assistant Surgeons.

(3) *Civil medical services.*

(*a*) I. M. S. in civil (e.g., State).

(*b*) Subordinate medical services (now called provincial).

(*i*) Civil Assistant Surgeons.

(*ii*) „ Sub-Assistant Surgeons.

(*c*) Women's medical service.

(1) *State medical services in general.*—We shall leave the R. A. M. C. (military service) for a moment and examine the I. M. S.

Its total cadre strength ..	..	766
Number in military employ	..	404 = 53 per cent.
Number in civil employ	..	362 = 47 per cent.

Distribution of those in civil employ =

Civil Surgeons and Administrative Medical Officers, etc. ..	..	279
Foreign and Political ..	..	47
Government of India ..	..	36
		362

The Indian Medical Service exists under Royal Warrant.

I. M. S. candidates after examination do two months at the R. A. M. C. College, Millbank, and two months at Aldershot before proceeding to India where they are attached to a large Indian Station Hospital for a course of instruction and for sanitary work, etc. They have the further advantage of being able

to attend courses at the Calcutta Tropical School, also a malariology course at the Ross Experimental Research Institute, X-Ray work at the Dehra Dun Institute, serology at Calcutta, and bacteriology at Kasauli, if and when specially selected.

The question of "Rank" at one time perturbed both Services; but, eventually, concessions in this regard were gained by the R. A. M. C. and these were extended to the I. M. S. soon after. Questions regarding pay, pension, family pension, furlough and study leave, appointment by nomination and examination, honours and rewards, etc., have from time to time agitated various members of the I. M. S.; but it continued to pursue its line of development undisturbed and to recruit the cream of the schools at home until the strain of the great war and its aftermath, with sequelæ, shook it to its foundations. Superadded to these were the uncertainties due to the effects of the Medical Services Committee's Report, of the Public Services Commission, and finally, of the Reforms. The result has been that this grand old service—truly a medical "service d'élite"—threatens to pass into a state of rapid decline from inability to recruit the type of officer it has so long known. The Indianisation of such a service to a fixed percentage on a time scale must help to hasten this decline as no Indian recruitment at the present time on such a scale and at such a pace can hope to take such cognisance as it ought to of selection by merit. Some of the best friends of India as well as of the Service are firmly of opinion that, for the next generation or so, India will want the very best type of European that the home schools can produce in order that the influence and example of much that is past may not be forgotten before it is too late. If such men are welcomed and treated well then much may still be done to avert this declension. It must, however, be faced by all communities in no mean sectarian spirit but in the broadest one possible.

(2) *Military medical services.*

(*a*) *R. A. M. C. and I. M. S.* (military). The organisation of the army is on fixed establishments evolved for the needs of the army in peace and war. That for medical relief

centres round the Station Hospital system, British and Indian, whilst that for sanitation falls under a Director of Pathology and Hygiene who is the staff officer for Public Health to the Director of Medical Services in India. The work done in this Department centrally, divisionally and regimentally is usually well done and well supervised and should serve as a great example to the sepoys as well as to the general Indian community. It is really a model demonstration of the economic benefits of good housing and careful hygienic control—in short, of preventive medicine—in the tropics.

(*b*) *Subordinate medical services* (including Indian Medical Department).—As early as 1639 the Company's Surgeons employed in their hospitals, Indians who, at first, were ordinary servants trained locally to act as dressers. When the Company raised a standing army Indian medical attendants were appointed to each corps and regiment. Up till 1750 these were the only medical subordinates employed, and, from such beginnings sprang the present subordinate and provincial medical services consisting of: (1) the military assistant surgeons, (2) the military hospital assistants (now sub-assistant surgeons), (3) the civil assistant surgeons, and (4) the civil hospital assistants (now sub-assistant surgeons). A Military Subordinate Medical Department came into being in Madras about 1760 though no record of definite sanctioning orders seems to have been preserved. It owed its existence to the energy of individual medical officers, who not only trained private soldiers and Eurasians to assist them in their hospital work; but at first paid them from hospital allowances. Gradually the best of these were brought on to a paid establishment of the medical department under the title of Sub-Assistant Surgeons. A subordinate class also existed in Bengal, though the records contain little reference to them. Out of this originated the Indian Medical Department.

(*i*) *The Indian Subordinate Medical Department* (Assistant Surgeon Branch).—This Department was known as the Military Medical Subordinate Department (I. S. M. D.) till 1918. In Bengal it was constituted early in the nineteenth

century; in Madras it began about the same time, and a little later in Bombay. In 1894 the designation was changed to "Assistant Surgeons" and in 1908 the three Presidency establishments were amalgamated. At present Military Assistant Surgeons are Europeans or Anglo-Indians recruited and trained at the expense of the State for service in hospitals for British Troops. They now undergo a five years' course of training at the various medical colleges in India. This demands a higher standard of preliminary education from the pupils and entitles them to appear for the Indian University examinations and also to proceed to take British qualifications. On passing out they are gazetted as officers with warrant rank, divided into four classes, promoted in these classes on a fixed time scale; and 10 per cent. of the military establishment of 381 including military miscellaneous appointments receive Commissions and are called departmental officers with the rank of Lieutenants, etc. About 232 of this branch of the Indian Medical Department are employed in peace time as a war reserve in various capacities in the Civil Department in a way similar to the I. M. S. They are liable to be recalled to military duty at any time. The Senior Assistant Surgeons among these are also promoted under certain conditions to commissioned ranks. Facilities are given to proceed to United Kingdom and obtain registrable qualifications and about 50 officers have qualified in this way. Those who have obtained such qualifications and are suitable in other respects can enter the Indian Medical Service by competition.

(*ii*) *Military Hospital Assistants* (now called the Sub-Assistant Surgeons).—A school for training native doctors was established under the Medical Board in Calcutta in 1822, the students being attached to the various hospitals. This school was removed to the new medical college in 1839 and to the new Campbell Medical School at Sealdah, Calcutta, in 1873. It has educated native doctors for civil rather than military employment; the requirements of the Army being supplied chiefly from the medical schools opened at Agra in 1853 and Lahore in 1860 (subsequently transferred to Amritsar). In 1895 the three

Presidency establishments were placed under the orders of the Director-General, Indian Medical Service; in 1900 the branch was reorganised on considerably increased rates of pay and in 1910 the title was changed to "Sub-Assistant Surgeon." At present these men are Indians who are recruited primarily for work in military hospitals; but are also employed in the Civil Department. They are educated by the State. After a training of four years in the medical schools and after passing the examinations they are gazetted as warrant officers. After five years' service the rank of Jemadar is conferred on them, and further promotion depends on vacancies and selection. Nine officers of this Department hold Honorary King's Commissions. The total strength of Sub-Assistant Surgeons in military employment = 739 and in civil employment = 141. The present number in civil employment is 126. All except those serving with the Indian State Forces, Frontier Militia, Levy Corps and Medical Stores Depôts are liable to be recalled at any time for military duty.

(3) *Civil medical services* (*State*).

(*a*) *I. M. S. in civil.*—The three Presidency medical services are administered by the three Surgeons-General and the other provincial medical services are in a similar way under the control of Inspectors-General of Civil Hospitals. At present 279 I. M. S. officers are in provincial cadres. The Surgeon-General or Inspector-General of Civil Hospitals as administrative medical head advises the local Government in all provincial medical matters and controls recruitment, transfer and promotion in addition to supervising hospitals, dispensaries, lunatic asylums, etc. Officers in civil employ have many avenues of special employment which are described in some detail under Paragraph IV.

(*b*) *Civil Subordinate Medical Department* (now called "Provincial").—This consists of Assistant Surgeons and Sub-Assistant Surgeons and the cadres are provincial. In 1833 an unsuccessful attempt was made to found a civil sub-medical department in Bengal, though a school for native doctors had

been opened in Calcutta in 1822 and was transferred to the new medical college in 1839. The foundation of the medical colleges—those of Calcutta and Madras in 1835 and that of Bombay a little later—provided the opportunity by requiring a higher standard of education. The first graduates of the Calcutta Medical College qualified in 1839 and were designated Sub-Assistant Surgeons; but in 1874 the title was altered to "Assistant Surgeon." At the present day the strength of the Provincial Medical Department is 968. In 1898 it was arranged that a certain number of Civil Surgeoncies should be reserved for and filled by Civil Assistant Surgeons. The number was fixed at 19 for the whole of India, but was later on increased to 28. The Civil Assistant Surgeons from the first were recruited and organised provincially, i.e., in separate cadres one for each province.

(*ii*) *The Civil Hospital Assistants.*—The formation of this Service was ordered by Government of India in 1878. Prior to this date all subordinate civil duties had been performed by military native doctors and Hospital Assistants, whose services were only lent to the civil Governments and who were at all times liable to recall to military duty. A separate cadre of Civil Hospital Assistants was then organised for each province and Military Hospital Assistants then serving were allowed to volunteer for transfer to any province in the new civil branch. There are five grades in the Department and since 1910 the title of "Sub-Assistant Surgeon" was introduced. They number 3,849.

(*c*) * *Women's Medical Service.*—This side of medical activity was not referred to in the account of the State services as it merits special treatment. Here again we must refer to the beginnings which were made largely by missionary effort. The first hospital for women and children was opened in 1869 in Bareilly, United Provinces, under the American Methodist Episcopal Mission, to be quickly followed by work at Lucknow, Delhi and other places in North India, and, in 1883, by the

* I am indebted to the office of the Chief Medical Officer, Women's Medical Service, for these facts.

Cama Hospital in Bombay which became the first Government hospital in India for women and staffed by women. Gradually Madras, Guntur, Lahore, Bengal, Indore, Allahabad and Cawnpore followed suit. Missions of various denominations have played a conspicuous part in the development.

A further stimulus came with the opening of medical schools and colleges to Indian women and the creation of "The Countess of Dufferin Fund" or the "National Association for supplying female medical aid to the women of India," founded in 1885 by Lady Dufferin at the request of the late Queen Victoria, and dedicated to medical education and relief and to the provision of nurses and midwives for hospital and private work. Scholarships were granted, and its effect on medical relief work was immediate by raising standards of recruitment and providing building funds and grants-in-aid.

From this eventually emerged the Women's Medical Service, due largely to dissatisfaction with the smallness of the previous effort, and to the obvious need for extension and better cadre organisation. A subsidy by Government to the Dufferin Fund made it possible, and, in 1914, it started with a cadre of 25 "registered" members, the Chief Medical Officer being also first Secretary of the Fund. The subsidy was increased in 1917 and the cadre raised; and, in 1925, a "training reserve" of 8 was added. It now has a cadre of 44 + 8 (reserve) = 52, 11 members being engaged in educational and 3 in administrative work. A 50 per cent. Indianisation scheme is being worked to.

Medical education was at first mixed. This proved difficult; but Madras, under Mrs. Scharlieb, led the way to women's hospitals staffed by women for teaching as well as medical relief, and their numbers increased rapidly. The opening of the Ludhiana School was a landmark; but, by 1912, this had led to a further demand which was met by Lady Hardinge's proposal to found a Medical College for women in order to encourage the best classes of Hindu and Musalman women to come forward for training. The College, which bears her name and was opened in 1916, stands in 54 acres, has accommodation for 120

resident students of all races and religions from all India, and is affiliated to the Punjab University for its M. B., B. S. degree. It is now turning out graduates and is run at an annual cost of 4½ lakhs. Since then three other government medical schools have been opened, thus making one medical college and four schools in India staffed by women and with a student enrolment of 392. There are now 17 hospitals officered by the W. M. S. officers; a large number of second class hospitals under local bodies; many female departments of civil hospitals, and Mission Hospitals. The Chief Medical Officer of the Women's Medical Service has the right of inspection of all hospitals officered by the W. M. S.

Maternity and Child Welfare Work.—From lack of public opinion and education and from conservatism and lack of suitable personnel this work is still in its infancy. The local midwife or *dai* still reigns supreme in the country, and it is only in the larger towns that her methods are seriously challenged by the various organisations which have been created to try to educate and improve or eliminate her. Pecuniary interests no doubt helped in dissuading the members of this class from coming forward for training.

In 1902 the Victoria Memorial Scholarship Fund was inaugurated by the late Lady Curzon, and, with an income of Rs. 40,000 per annum, has done much in training those *dais* who were willing. Those who are in a position to know assert that there are many signs in the big towns of a breaking down of the old conservatism on the part of both *dai* and patient. Doctors, voluntary societies, and health visitors are all engaged in the training. Meantime highly trained midwives are being turned out by the large hospitals; but their registration is still awaited, though attention to it is developing in some provinces.

Child Welfare Work, though still in its infancy, is progressing with some rapidity, due partly to the organisation for training Health Visitors and very largely to the work of the Lady Chelmsford League. The funds of the League amounting to Rs. 50,000 annually go to establishing Health Schools for training

Health Visitors, to propaganda and to grants-in-aid. Four Health Schools aided by the League now exist at Delhi, Lahore, Calcutta and Madras, and two others (non-aided) at Poona and Nagpur. Baby Weeks, Health Weeks, Exhibitions and Conferences are all succeeding in bringing this work into prominence in the larger towns, and, were it not for the lack of trained workers, the lessons to be learned by the millions of mothers in India would be learned much more rapidly.

4. Civil Medical Fabric.—The reader will now appreciate the evolution of the great medical edifice on western lines which has been built up during the past two centuries, and which is very largely indebted for its creation to the work of many generations of officers of the Indian Medical Service. In later years this service has been assisted in its work by the independent medical profession both European and Indian, male and female, by the Women's Medical Service under the Dufferin's Fund, and by the subordinate medical services both civil and military. Some of the activities in this great edifice are described in more detail in the following paragraphs.

(*a*) *Medical Relief.*—Provinces are divided into divisions, each of which consists of several districts. The average population of a district may be taken at one million. Each district has a headquarters for all Government departments, one of which is the "medical," presided over by a Civil Surgeon who is usually responsible for all medical and public health activities in his district area. Besides managing the headquarters hospitals (i.e., Civil Hospital, Police, Canal, Eye, Leper, etc.), he controls in his area several branch hospitals under Assistant Surgeons and many dispensaries under Sub-Assistant Surgeons, inspecting them usually quarterly. His work is largely in the hospital, though much of it is supervisional and administrative.

273 Civil Surgeons and specialist officers (of whom 152 are I. M. S. officers) working under the respective provincial Surgeons-General or Inspectors-General direct the management of over 5,000 civil hospitals, mental institutions, dispensaries, leper and tuberculosis institutions with over 75,000 beds. Every

year they treat on an average over 43 million patients at an approximate cost of over 3½ crores of rupees (£2½ millions) and do over 1½ million operations. In addition, over 600 private non-aided hospitals and dispensaries, with over 8,000 beds, treat some 5 million patients and show over 1,50,000 operations.

The Women's Medical Service with a cadre of 44 and a reserve of 8 supplies medical relief in many female hospitals while the private effort of missionary organisations has come to the rescue and has filled up many of the gaps.

(*b*) *Medical Education.*—506 Professors and Assistant Professors teach the medical curriculum in eight State Medical Colleges and 23 State Medical Schools in which 8,899 students were enrolled in 1925.

The Women's Medical Service has organised medical education in one women's medical college and four medical schools where 392 women students were enrolled; while 244 others are studying at five mixed colleges and 7 mixed medical schools.

The following degrees and licenses are granted:—

(*i*) Doctor, Bachelor and Licentiate of Medicine and Master and Licentiate of Surgery of the University of Bombay, Calcutta, Madras, Allahabad and Lahore; and Bachelor of Medicine and Bachelor of Surgery of the University of Lucknow.

(*ii*) Fellow, Member and Licentiate of the College of Physicians and Surgeons, Bombay.

(*iii*) Fellow, Member and Licentiate of the State Medical Faculty of Bengal.

(*iv*) Fellow, Member and Licentiate of the State Medical Faculty of Punjab.

(*v*) Licentiate and Apothecary of the Board of Examiners, Medical College, Madras.

(*vi*) Licentiate of the State Board of Medical Examinations, United Provinces.

(*vii*) Licentiate of the Bihar and Orissa Examinations Board.

(*viii*) Licentiate of the Burma Medical Examinations Board.

(*ix*) Licentiate of the Central Provinces Medical Examinations Board.

(*x*) Licentiate of the Assam Medical Examinations Board.

Registration.—The granting of medical degrees, diplomas, licenses, etc., in British India permitting the practice of "Western Medical Science" is regulated by the Indian Medical Degrees Act VII of 1916. Western medical science refers only to the western methods of allopathic medicine, obstetrics and surgery, and does not include the Homœopathic or Ayurvedic or Unani systems of medicine. Under the provisions of this Act such Provincial Universities and Medical Colleges, etc., as are authorised by the Governor-General-in-Council may grant medical degrees, diplomas, etc.

The registration of medical practitioners is governed by Provincial Medical Acts which are enacted by the Provincial Authorities with the sanction of the Governor-General and which are controlled by Medical Councils consisting of nominated and elected members. All provinces have their own separate Medical Acts except the North-West Frontier Province and Delhi and Baluchistan and the Agency Tracts of Central India and Rajputana. The provisions of the Punjab Medical Act are applicable to the North-West Frontier Province and Delhi. There are no Medical Acts in the Indian States but the diploma granted by the Indore Medical School is recognised in Bombay and the Punjab, and that granted by the Medical School, Hyderabad (Deccan) is recognised in Bombay and Madras.

Provincial Medical Acts permit the registration, on payment of a fee, of all persons who are registered or qualified to be registered under the British Medical Act—1858 Statute 21 and 22, Victoria Chapter 90, and of all those who are in possession of medical degrees or diplomas, etc., granted by the Universities or Medical Colleges or Schools empowered to do so as shown in the schedule to the Act. The payment of a fee is required from all medical practitioners irrespective of whether they have been previously registered elsewhere or not, except in the Bombay

Presidency and the Punjab. In Bombay exemption is granted to all persons who are already registered under the British Medical Act, and, in the Punjab, no fee is charged to those who may be registered under any Medical Registration Act in force in any other province in India.

An all India Medical Registration Act is now under consideration of Governments.

(*c*) *Public Health.*—Nine Directors of Public Health of whom 8 are I. M. S. officers with 33 Assistant Directors of Public Health and other subordinate staff control the provincial public health departments of 11 provinces. They administer 10 Public Health Institutes and 8 Lymph vaccine manufacturing depôts producing sufficient vaccine for nearly 10 million vaccinations at an average cost of about 5 annas 2 pies per successful operation. Recent developments envisage whole time district health officers in every district as well as municipal health officers. This is gradually being worked to, thus eliminating the overworked Civil Surgeon from the control of purely health work.

(*d*) *Research, Pasteur, X-Ray, Radium Institutes.*—74 medical officers of whom 20 are I. M. S. staff 10 institutions engaged in anti-rabic work, vaccine and serum production, teaching, specialised treatment, routine work, or medical research. The Pasteur Institutes in 1925 treated over 30,000 cases.

(*e*) *Prison Administration.*—45 medical officers of whom 29 are I. M. S. under 9 Inspectors-General of Prisons act as whole time medical Superintendents of 46 Central Jails throughout India. In addition, in most district jails throughout India the local Civil Surgeon acts as Jail Superintendent and Medical Officer in addition to his other duties.

(*f*) *Foreign and Political Department.*—37 officers, all of whom are I. M. S., act as Residency Surgeons and Administrative Officers of certain areas in Indian States territory and adjoining countries.

(*g*) *Chemical Examiners Department.*—6 officers of whom 5 are I. M. S. act as Chemical Examiners in the various provinces.

(*h*) *Other Miscellaneous Appointments.*—One officer of the I. M. S. is Director of the Zoological Survey of India, one is Marine Naturalist to Government, one is Serologist to Government.

B. Research Organisation.

Though the genesis of the present research department dates back only to 1900, the events which, over the previous two decades, led up to the formation of this department through the creation of the Kasauli and Bombay Institutes are so interwoven that a short historical survey of them is essential to any proper appreciation of its evolution.

This survey takes us back to the year 1869 when Government of India appointed Drs. Lewis and Cunningham as special assistants to the then Sanitary Commissioner with the Government of India for the ostensible purpose of utilising scientific investigations for the benefit of public health. Bacteriology was then in its infancy, and, though, during the next 25 years, much new ground was broken by these officers, they did much of it in addition to other routine duties. Lewis went to Netley in 1883, and Cunningham, though Professor of Physiology in Calcutta from 1879 till his retiral in 1897, ran during most of this time a small laboratory—the only one of its kind then in India. Largely through the impetus thus given to specialised research, especially on cholera, other enquiries were instituted by Government of India such as those on malaria, beri-beri and kala-azar by Ross and Giles. In 1892 the advent of Mr. Hankin to Agra as Chemical Examiner brought into the Indian field an original worker saturated with the bacteriological doctrines and teachings of Pasteur and Koch and with a facile brilliant pen which did much to educate and stimulate the profession. Such a stimulus helped to lead up to the Lahore meeting of 1893 at which the necessity for the founding of a Pasteur Institute for India was agreed upon; a decision which was homologated by a resolution of the Indian Medical Congress at Calcutta in December 1894 and eventually resulted in the opening of the Pasteur

Institute of India at Kasauli in 1900—a scheme which had been accepted in principle by the Secretary of State in 1892.

Whilst various proposals for the establishing of a bacteriological laboratory for all India work were being discussed, plague appeared in Bombay in 1896, and Mr. Haffkine, the memory of whose services has been preserved in the present designation of the Bombay Institute, was transferred from Bengal, where he was doing cholera inoculation work, to Bombay, to investigate the bacteriological side of this problem, as he was then the only whole time bacteriologist in the country. The future researches in plague centred round the laboratory which he created in 1896 in Bombay; but the history of this and of his work will be found in another chapter. After occupying various temporary laboratories he eventually came to rest in old Government House, Parel—the Bombay Institute which now bears his name. He was associated in his work there with Warden, Mayr, Gibson, Marsh, Balfour-Stewart, Pitchford, Bannerman, Cayley, Corthorn and at a later date with Lamb, Liston, Greig, Costello and Chowsky. He finally left for Europe in May 1904 when Lt.-Col. Bannerman assumed the direction of the laboratory, and, with Liston, prepared the way for the advent of the Plague Commission with Professor C. J. Martin at its head in April 1906. The laboratory work of this Commission which dealt with the enquiry into the etiology of plague was done at Parel. This was a decade full of anxiety and hard pioneer work.

Let us go back to 1896 and to the plans which were then being put forward for a central bacteriological laboratory. Agra had been suggested and ruled out; a scheme by the Inspector-General of Civil Hospitals, Bengal (Colonel Hendley) for a whole time bacteriologist in Calcutta failed to find supporters; delay was caused by an alternative scheme of the Rana of Dholpur for a Princes' Health Institute; finally, that of the Director-General, Indian Medical Service (General Harvey) was accepted by local Governments and by the Secretary of State.

This scheme, which was much the same as one outlined by Dr. (now Sir) Almroth Wright, after discarding Parel and

Muktesar as possible sites, chose Kasauli, and envisaged the creation of a Central Research Institute there under a senior officer. This eventuated in 1906. Coincident with this scheme were two others. In 1902 Secretary of State had sanctioned a Presidency Bacteriologist and a central Vaccine Institute at Madras and these materialised in the King Institute of Preventive Medicine at Guindy, opened in August 1904. In 1903 Government of India arranged with Madras Government to establish an Anti-rabic Institute for Southern India and helped to subsidise it. Coonoor was chosen as the site, and a Director and Assistant Director (Cornwall and Kesava Pai) trained and in due course appointed.

Government of India had already in 1900 addressed the Secretary of State on a scheme for the creation of a regular Bacteriological Department with laboratories. Allowance scales for I. M. S. officers were suggested and recruitment was not to be confined to the I. M. S. This scheme was accepted the same year; but by 1906, in accordance with a revised and enlarged scheme (approved on 8th June, 1905), Government of India had provided for a Central Research Institute at Kasauli, the Anti-rabic Institutes at Kasauli and Coonoor, and the provincial bacteriological laboratories at Madras and Bombay, and, hoped eventually, to place one suitably in each of the other provinces. These were staffed by officers of the Bacteriological Department, Kasauli Pasteur Institute having a Director (Major afterwards Sir David Semple) and Assistant Director, and the Central Research Institute, Kasauli, having at first a Director and later three other officers. Dr. Gibson (a non-I. M. S. officer) was appointed permanently and later became Director of Guindy.

With the opening of these Institutes and the consequent expansion of this branch the question of organising a special cadre arose. In 1906 the Secretary of State finally sanctioned this in a scheme providing for the entry of such officers into a "Bacteriological Department" where their relative seniority would be fixed. Despite certain vicissitudes this represents the department of to-day though it has grown numerically and

expanded its activities. The first cadre consisted of 13 posts, 4 being at the Central Research Institute, Kasauli, 3 at Bombay, 2 each at Madras, Coonoor, and Pasteur Institute, Kasauli. Government of India wisely created it an Imperial Department thus recognising the all-India claims of medical research, ensuring more efficient administration, and reserving to themselves the power to appoint or withdraw officers though giving full administrative as well as a large measure of technical control to provincial Governments.

In 1914 Government of India increased the cadre by 15 mainly to allow of an extension of field investigations—a branch of work which had been pursued with some difficulty by engaging such professional workers as were suitable or available, whether service or otherwise (at one time 16 were so employed). In 1915 the cadre was increased by 2 (total 30) to allow of staffing the Directorships of the new Pasteur Institutes at Rangoon and Shillong; whilst it was recognised that the posts of Assistant Directors at the Pasteur Institute of Kasauli and Coonoor could be held by Assistant Surgeons, thus freeing two I. M. S. men for field research but not reducing the cadre. These two posts on the cadre were eventually made to cover the special duty officer at the Haffkine Institute, Bombay, and the supernumerary post of Assistant Director at Rangoon (sanctioned in 1921). The Department, though continuing on this basis, was depleted during the Great War, when " research " came to a standstill, and the main energies of these officers who were left were concentrated on vaccine production for the Armies and on routine work. In 1922 the Department was reorganised, and, with a view to making it more attractive, the conditions of service were improved; but, independent of this, in 1919 a scheme was promoted by the Hon'ble Member for Education and Health and sanctioned by Secretary of State in November 1920 by which a Public Health fund of five lakhs was created for the development of a central organisation dealing with epidemics and research; and in this connection a Central Health Board and the posts of Director of Medical Research, and of Epidemiological Statistician were

created. The necessity for these and their value do not require elaboration; but they were not allowed to function for long as the post-war economies of the Indian Retrenchment Committee under Lord Inchcape led in 1923 to the abolition of the two former just before the third post had been filled.

This had its repercussion on the Bacteriological Department in three ways. It deprived the Department of a co-ordinating head in the new Department of Research, it led to eleven of the posts on the permanent research cadre being held in abeyance, and it led to the suspension of an annual grant of five lakhs for research to the Indian Research Fund Association.

A word regarding the Indian Research Fund Association. This Association, which is a much older body than the National Research Council in Great Britain, was constituted soon after the Bacteriological Department was regularised (about 1906-07), with the object of ensuring a continuous supply of young workers of adequate calibre and of attacking such medical research problems as awaited solution. The Hon'ble Sir Harcourt Butler who was then Member for Education, with rare foresight instituted the Association and arranged for its control by a representative Governing Body advised by a Scientific Advisory Board which is a purely technical expert committee (at present composed of the Director-General, Indian Medical Service, as Chairman, Public Health Commissioner as Secretary, and Directors of the major laboratories as members). An annual Government grant of (£37,500) five lakhs to the Association enabled it to finance enquiries and to accumulate a capital fund for the purpose of founding an Imperial Medical Research Institute which will be adverted to later. It was the income derived from this capital fund which helped to tide the department over the lean years after the Retrenchment Committee had cut the annual grant.

Journal.—The official organ of publication of the Association is the * *Indian Journal of Medical Research* which replaced

* The subscription to the *Indian Journal of Medical Research* including *Memoirs* is Rs. 16 (or one pound, one shilling and four pence) per volume per annum, post free. (Thacker, Spink and Co., Calcutta.)

the Scientific Memoirs of the Government of India and has now firmly established itself in a high position in the scientific world. Four quarterly numbers are published each year and in addition subscribers obtain special Memoirs.

Imperial Research Institute.—In 1920 Government of India came to the conclusion that considering the enormous importance of medical research in India, the existing arrangements for it were inadequate, and that a central institute was required to provide for co-ordination, mutual assistance, ample laboratory facilities for special workers and for the various modern departments. Before proceeding further they invited Professor E. H. Starling, C.M.G., F.R.S., of University College, London, to visit India and advise them. As a result of this visit Delhi was chosen as the most suitable site, the idea being to retain Kasauli Institute for vaccine production. Plans of the proposed Institute were prepared and included provision, not only for laboratories for bacteriology, medical biology, chemistry and pharmacology, for a library and stores, but also for a small hospital to act as a clinical unit. The training of Indians as research workers was one of the rôles assigned to the Institution, and Professor Starling suggested that 20 research scholarships should be instituted to this end. The scheme, which was to cost 17 to 19 lakhs with a recurring cost of five, was generally approved by the Secretary of State, and the Standing Finance Committee agreed to recommend it to the Legislative Assembly; but, in consequence of the recommendations made by the Indian Retrenchment Committee, the scheme was held in abeyance.

Now that the * financial conditions have improved a reconsideration of the scheme is taking place; but, in view of the changes that have occurred since Prof. Starling's report, more especially in view of the great advances in certain aspects of research work, it was agreed that as a preliminary the whole question should again be examined by a committee with the

* Full grant of five lakhs has now been restored and also all appointments held in abeyance except two (Total 28).

necessary expert knowledge and on whose report sound action could be based. Arrangements for this are now in train.

Calcutta School of Tropical Medicine and Hygiene is another provincial institution requiring special notice. Since 1920, largely as the result of the labours of Lt.-Col. Sir Leonard Rogers, *Kt.*, F.R.S., I.M.S. (Retd.), and of the late Director-General, Indian Medical Service (Sir Pardey Lukis, K.C.S.I., I.M.S.) this School has come into being. The influence it is exerting on research, both in its educational rôle and by direct example, is great. It is controlled by a Governing Body. In the last annual report the Director, in a historical note,* has traced the origin and set forth the aims of this institution, and a series of sectional reports by individual Professors deals exhaustively with the work now being done. The School is divided into five sections—a Tropical Medicine Section, an Institute of Hygiene, a Pasteur Institute, the Leonard Rogers Laboratories, and the Carmichael Hospital for Tropical Medicine. Each of these has a large staff of professors, lecturers, and assistants. Research work is being carried forward on kala-azar, hookworm, intestinal infections, leprosy, filariasis, diabetes, radiology, skin diseases, blood changes, indigenous drugs, epidemic dropsy, drug addiction, malaria, bacteriology, pathology, protozoology, pharmacology, entomology, serology, chemistry, hygiene, and tropical medicine generally.

Present Position.—The position now is that the Department is Imperial or Central, is open to I. M. S. and to non-I. M. S. men, has a cadre of 30 posts, 15 of which are specified and 15 non-specified, and 2 of which are still in abeyance. The 15 specified appointments are those of Directors and Assistant Directors at the Central Research Institute, Kasauli, Haffkine Institute, Bombay, King Institute, Madras, Pasteur Institute at Kasauli, Coonoor, Shillong and Rangoon. Only the Central Research Institute, Kasauli, is directly under the control of the Central

---

* Annual Report of the Calcutta School of Tropical Medicine Institute of Hygiene, and Carmichael Hospital for Tropical Diseases, 1926. (Bengal Government Press, Calcutta.)

Government. Officers holding unspecified posts are either attached to provincial institutes under the orders of the Director-General, Indian Medical Service, to learn work and to under-study, or they are engaged in carrying out particular researches under the Indian Research Fund Association. The Department is under the control of the Government of India in regard to appointments, transfers, etc. The Department comes under the Director-General, Indian Medical Service, but is administered for him by the Public Health Commissioner who is also the Secretary of the Governing Body of the Indian Research Fund Association. He acts in association with the Director of the Central Research Institute, guided by a Scientific Advisory Board composed of senior officers of the Research Department and major laboratories, and which in turn advises the Governing Body. Intimately associated with this Department are the research activities promoted under the auspices of the Indian Research Fund Association. During the current year 58 different researches, conducted or directed by members of the Department, and by outside workers of repute both from the services and from the independent medical profession in India and Europe, are in train throughout India at a cost to the Association of approximately Rupees twelve lakhs (£80,000). These enquiries include researches by a Commission on Kala-azar, by a Central Malarial Organisation on malaria, and by special workers on malaria, plague, cholera, leprosy, helminthology, nutritional diseases, tuberculosis, sprue, maternal mortality, relapsing fever, skin diseases, diabetes, drug addiction, dysentery, diarrhœa, bacteriophage, statistics, biochemistry and pathology. Not the least useful of the more recent arrangements is the All-India Conference of Research Workers, which has met for the last four years at the Calcutta School, and has afforded all workers under the Association an opportunity of explaining the work they were engaged on, of consulting with their fellow workers and of speaking to their own research proposals for the ensuing year. The interchange of opinion has been all to the good, and the Conference has also been found of great value by the Scientific

Advisory Board and by the Governing Body as well as by the workers. This organisation makes control and co-ordination simple and effective.

Organisation versus Functions.—Organisation is closely linked with the functions of any department or institute. The main rôle originally assigned to the Central Research Institute was one of research—research undertaken at the instance of the Government of India or Public Health Commissioner to ascertain the cause of a particular disease amongst a particular class, or to enquire into the causation of an outbreak of disease, or, at the instance of the Director of the Institute or one of his Assistants, into some particular disease or bacteriological problem. To this had to be added the rôles of routine examination work, of vaccine and sera production, of education, e.g., technique and malaria, and incidentally of providing a reserve of workers for field and other enquiries. These rôles were more or less applicable to provincial laboratories in the early days with certain limitations, while Pasteur Institutes, which, as in the case of that at Kasauli, had begun by acting in several of the above capacities, were, except where specially provided for, kept to the rôle of Pasteur work and researches connected with it. As the work expanded and the organisation evolved certain institutions have come to specialise more and more in certain lines of work. Thus, to take two examples, the Central Research Institute, Kasauli, has developed the production of cholera and T. A. B. vaccines, anti-venomous serum, the malarial and entomological bureaux and other research, while Bombay has specialised in plague research, plague vaccine production, snake venom work, anti-rabic work, water analysis, pharmacology, and bio-chemistry, etc. This work will be explained in fuller detail in another article (Section XVIII).

The responsibilities of a Central Government in regard to medical research in its widest sense adumbrate adequate laboratory provision for research work on all aspects of the larger problems of disease as well as on more routine work. These have been visualised from the earliest days of the Department,

and it was largely a question of finance which interferred with the fruition of the plans prepared for the erection at Delhi of an Imperial Research Institute worthy of the country. The reconsideration now in train and already referred to has been rendered necessary by altered circumstances, and further expert advice on the whole question of the central organisation of Indian research on its widest basis has been sought with a view to the creation of an Imperial Research Institute on the most modern lines and in harmony with the present trend of research thought. The funds have been in great part provided and it may be that, eventually, this delay will have been found to react to the benefit of medical research in India.

*

VII.

MEDICAL RESEARCH IN INDIA.

BY

LIEUT.-COL. F. P. MACKIE, O.B.E., I.M.S.,

Director, Haffkine Institute, Bombay.

DURING the last hundred years or so medical research in Europe has proceeded in an orderly and well defined series of stages.

At first men depended on their unaided senses, their hands and eyes, and they continued and improved upon the clinical and epidemiological observations which had been handed down by the great clinicians of the past. Then came the era of the microscope when at first this instrument was used to confirm or elucidate the simple problems of clinical medicine and morbid anatomy. With the rise of parasitology the problems became more intricate and from amongst the clinicians there evolved the specialists in pathology, bacteriology, protozoology, pharmacology, biochemistry and of other sciences ancillary to medicine. This specialisation was rendered necessary by the ever-growing complexity of scientific research, and its requirements demanded special laboratories and costly equipment.

The evolution of research in India has proceeded on similar lines and this is not to be wondered at when we consider that research in India has not been indigenous in origin but has resulted from the application of European methods to Indian conditions. For this reason the growth of research has been in the past almost entirely due to the labours of the men of the Indian Medical Service for it is only of recent

years that Indians trained in Western methods have taken their share in this aspect of medical progress.

Early Pioneers.—In the early days such research as existed was almost entirely of a clinical nature and during this period notable work was carried on in hospitals and at the bedside in the elucidation and unravelling of symptomatology and in the study of epidemics. The names of men like Martin, Annesley, Wade, Malcolmson, Morehead, Chevers, Waring, Macpherson, MacNamara and others stand out as valuable contributors to clinical medicine and epidemiology just previous to and during the nineteenth century, and it is to such men as these that we owe the firm foundations on which valuable investigations in tropical pathology have since been built.

There have been pioneers in surgery too, particularly in diseases of the eye and in the technique of operations much demanded in India, such as those for stone in the bladder, elephantiasis, liver abscess and plastic facial surgery. The record of the older surgeons is not so complete as those of the physicians but the names of Freyer, Playfair, Keegan, Elliot, Henry Smith and Maynard in more recent times are noteworthy in connection with progress in special departments of surgery.

Then we come to the earlier observations with the microscope and amongst these were interesting discoveries, the value and significance of which was, in many cases, not fully realised till many years afterwards.

Timothy Lewis, an Army Surgeon, may be regarded as one of the pioneers of parasitology for he published a book in 1878 entitled "The microscopic organisms found in the blood of man and animals and their relation to disease." In this he describes an amœba which he discovered in the stools of cholera, the *Filaria sanguinis hominis* (now known as *F. bancrofti*) and the blood trypanosome of the rat which bears his name. The significance of the trypanosomes was further emphasised two years later when Griffith Evans a Veterinary

Surgeon, discovered the parasite now known as *T. evansi* and associated it with an outbreak of surra amongst horses, camels and other domestic animals in India.

In 1885 Cunningham described bodies in Delhi boils whose true nature was not apprehended till 1903 when Leishman discovered the well-known parasite of kala-azar to which Cunningham's bodies are now known to be closely allied and which are familiar to us as *L. tropica.*

Fayrer following Russell's footsteps is noteworthy as having written a classical monograph on the snakes of India which paved the way for much valuable work on venoms and their antidotes which has been done by subsequent investigators.

Last but not least we must mention Vandyke Carter who in the days when the microscope was still regarded as an instructive toy rather than a powerful agent for progress, used this instrument to such effect that he was able to write monographs on relapsing fever, oriental sore, leprosy and mycetoma which are still regarded as classical on these subjects. He was also responsible for the artistic drawings illustrating the famous "Gray's anatomy." He left India in 1888 and may be regarded as the last of the old school of pioneers.

Rise of Laboratories.—We now pass to the more fruitful researches of recent times, to the progress which is due to the rise of the microscope more than to any other one factor. At first men used this instrument as an accessory or aid to clinical observation, but gradually as skill and precision increased research with the microscope demanded more and more time and skill until it was found that laboratories were necessary and that men required to be specially trained and to be detached from the routine work of the Civil Surgeon.

It was in this way that laboratories have evolved until in the present day when research is initiated into a disease it

is necessary to co-opt the services of many ancilliary sciences and the principle of commissions and team work has arisen.

In the remainder of this article it will be convenient to take the prevalent diseases one by one and consider notable researches which have been done towards their elucidation.

Malaria.—The first to be considered both by reason of its widespread ravages in India and by reason of the prolific and valuable work which has been done on this subject is Malaria.

The discovery of the malarial parasite by Laveran in 1881 was verified quickly by several observers in India, by Vandyke Carter for one, but it was not till later that men's minds began to be directed towards the association of insects with disease. King in 1883 revived the older suggestion that mosquitoes might be carriers of malaria and eleven years later Manson added the weight of his opinion in the same direction. This malarial hypothesis of Manson was finally put to the test in India by Ross as a result of whose infinite patience and masterly technique the outstanding facts of mosquito infection, development and transmission were established once and for all. His researches were carried out on the transmission of bird malaria and his conclusions were found by his own subsequent work and by that of the Italian workers to be entirely applicable to the human disease.

Whereas any successful piece of scientific work is described as a romance, this work of Manson and Ross transcends romance and becomes an epic, for in addition to its intrinsic value one realises that much of the work on insect transmission of disease which has been done since owes its inspiration to the work of these pioneers on filariasis and malaria.

Since that time an enormous amount of work has been done on malaria in India, particularly by Christophers. In the earlier days he collaborated with others, notably with James, Bentley and Liston, and in more recent years he has

been in part responsible for advising or directing the researches of the younger generation of malariologists amongst whom we may mention Sinton, Barraud, Covell, Shortt, Gill and others.

This school of malariologists has been engaged in such diverse aspects of this problem as malarial surveys, the collection of epidemiological data, field experiments on mosquito reduction, the prevention of malaria in selected urban or rural areas, the forecasting of epidemics, the prophylactic uses of quinine, the collection and analysis of spleen indices and other methods of estimating the incidence of malaria.

Rogers, MacGilchrist, Acton and others have approached the problem from the therapeutic side particularly as regards the constitution and use of the quinine alkaloids.

In addition to these researches pioneer work has been done, much of it by Christophers himself, on the structure, life-history and taxonomy of mosquitoes at varying periods of their life history. In addition to the work which has emanated chiefly from laboratories a large volume of investigation has been done by the public health authorities in different provinces mostly in the direction of mosquito surveys and the practical measures to be taken for stamping out endemic malaria.

A Central Malarial Organisation has, at the instance of Christophers, been recently established. This organisation will unify, correlate and direct malarial enquiries throughout British India and will prevent overlapping of researches and consequent wastage of effort and money.

When one enquires into the effect of all this activity on the reduction of malaria in India, one is bound to admit that there is a great deal left to be desired. We have the knowledge but the application of it is difficult and expensive. The terrain in India is less favourable for anti-malarial experiments than that at Ismalia for instance, nor has India the resources of wealth and the advantages of popular co-operation which worked such wonders in Panama. The delegates to

this Conference will see during their tours the magnitude of the problems which India has to face and will learn of the limitation of her financial resources which has acted as a drag on the wheels of progress.

Plague.—The next great devastating disease of India is Plague and it is a cause of satisfaction to us that just as India discovered the key to the malarial problem so also was the transmission of plague discovered in this country. Plague was first recognised in India in 1896 and after raging in Bombay City it spread like wild fire eastwards and northwards through India. Several Commissions of experts from Europe and individual scientists who had theories to test, were attracted by the terrible drama which was being enacted but none of these enquiries bore the desired fruit and it was not until 1905 that an Advisory Committee on plague was formed in London and a small Commission was sent out to Bombay under Martin there to co-operate with investigators in India, of whom the chief were Liston and Lamb.

The former had already arrived at the conclusion that plague was carried to man by the rat flea and this was quickly proved by the Commission who issued a series of monographs which threw a flood of light on every aspect of the pathology and epidemiology of plague, and whose conclusions have been proved and acted on in every part of the world. Field experiments and transmission observations were subsequently carried on on an extensive scale by Gloster, White, Kunhardt, Chitre, Avari, and Cragg. Plague research is still carried on at the Haffkine Institute, Bombay, whilst a large amount of epidemiological and other field work is carried on in the endemic areas especially in the Punjab and the United Provinces. Fortunately for India Haffkine was working in Bombay on the outbreak of plague and he set himself to devise a protective vaccine. This he did so successfully that his methods are followed with little alteration in technique to this day. Continuous investigation has been

going on at the Haffkine Institute by various workers during the last 25 years under the successive directorship of Bannerman, Liston and Mackie.

Haffkine's prophylactic is made at the Institute in Bombay which was named after him and is distributed throughout India and in other countries of the East. This vaccine by raising the immunity amongst the inoculated brings about a marked diminution in the incidence of the disease.

Relapsing Fever.—Previous to 1907 this disease, which at times is very prevalent in epidemic form in India, was held to be transmitted by the bed bug. During 1906-1907 Mackie studied the supposed methods of insect transmission but after a long series of experiments failed to incriminate the bed bug. Just at the end of this time a smart epidemic broke out in a Mission School near Bombay and he was enabled to study its progress. He came to the conclusion on epidemiological grounds that the disease was being spread by lice and clinched this by finding that the internal organs of a considerable proportion of the lice taken from the infected wards swarmed with spirochætes whilst lice from the uninfected wards were free. These infected lice gave rise to the disease when injected into monkeys. This discovery was quickly confirmed by the French workers and Mackie's observations were extended and in one part corrected by Nicholle and his collaborators who found that relapsing fever was transmitted not by the bites of lice but by the excoriation produced by scratching. From the close epidemiological similarity existing between relapsing fever and typhus Nicholle was led to experiment on the latter disease which he proved was also carried by lice. Further light has been thrown on spirochætosis in India by Bisset, Cragg and Cunningham, whilst typhus, which exists only in limited areas of northern India, was particularly studied by Cragg who lost his life in the pursuance of these researches. Megaw has brought good

evidence to show that there is a tick-borne disease resembling typhus existing in some parts of the Himalayas.

Kala-azar.—Epidemic Kala-azar is a peculiarly Indian disease and previous to Leishman's discovery in 1903 it was confounded with other diseases particularly with malaria, beri-beri and ankylostomiasis. Leishman's discovery of the parasite (in the spleen of a soldier who had contracted the disease in India) was quickly confirmed by Donovan who found it by spleen puncture in cases of kala-azar in Madras. Rogers by successfully cultivating the parasite outside the body proved that it belonged to the genus *Herpetomonas* and not to the *Piroplasma* as Laveran had supposed. The morbid anatomy and microhistology of kala-azar was worked out by Christophers whilst James showed how it differed from chronic malaria. For nearly twenty years the disease has been the subject of investigation particularly by Rogers, Dodds Price, Christophers, Bentley, Cornwall, La Frenais, Patton, Mackie, Knowles, Napier, Young and Shortt; whilst oriental sore has been particularly studied by Patton and Row. Led by the epidemiological studies of Rogers and Price, backed by the optimistic laboratory experiments of Patton during all this period the bed bug theory of transmission held the day. During the last few years doubts began to arise as to this method of transmission, and some other insect was looked for whilst the possibilities of intestinal infection were reconsidered. The finding of flagellates in sandflies in Assam by Mackie, the observations by Acton on the coincidence of the distribution of sandfly bite with leishmanial sores and above all the work on oriental sore in Tunis (incriminating this same insect as the probable transmitter of another leishmanial disease) combined to turn the attention of investigators to the potentialities of the sandfly. Then followed the notable researches of Knowles, Napier and Smith in Calcutta who found that *Phlebotomus argentipes* could be readily infected with leishmania by feeding them on kala-azar patients. At

last it seemed as if the solution of this long-sought problem had been found and this belief was strengthened by the investigations on the development of leishmania in sandflies by Shortt and his associates who were working in Assam on a Kala-azar Commission under the direction of Christophers. The only link yet to be forged to complete this important investigation is the proof that infected sandflies can transmit the disease to man. This proof is awaited.

Kala-azar has already lost much of its terror now that we have a specific treatment in the salts of antimony. This fact was discovered by the Brazilian physicians and its results were tried in Italy with equal success subsequent to which tartar emetic was introduced into India by Rogers and its value made known by his powerful advocacy. It is now used almost universally and effects a cure in not far from ninety per cent of cases. Improvements in the chemical composition of antimony salts have been made by Brahmachari and others who have produced preparations safer of administration and of greater potency.

Diseases due to Trypanosomes.—When human sleeping sickness was ravaging Uganda fears were expressed that the disease might spread to India. The Government of India foreseeing this contingency deputed two of its officers to join the Sleeping Sickness Commissions which were successively directed by Bruce in Uganda.

Greig first and later Mackie were privileged to study this formidable disease and to take their share in elucidating the problems which it presented. The disease was found to be dependent on the presence of the trypanosome in the wild game and was spread to man by the agency of tsetse flies. As India is free of this infection amongst wild animals, so far as is known, and certainly has no flies of the genus *Glossina* she may be considered safe from the spread of this disease even were it introduced.

The trypanosome disease of domestic animals, **surra**, is common in India and much work has been done on the subject by officers of the Veterinary Department to which Rogers has also contributed. Christophers and Patton carried out valuable researches into the transmission of piroplasmosis, an allied disease of domestic animals, and the former has worked out the transmission cycle of these parasites in ticks.

Intestinal infections.

Typhoid Fever.—Typhoid fever was at one time considered to be rare in Indians though always a danger to young Europeans freshly arrived in this country. The clinical studies of Rogers and the laboratory investigations of Semple and Greig showed that Indians were prone to the disease and the immunity of adults was explained by their having gone through an attack earlier in life. That Indians possess no racial immunity to typhoid fever was amply demonstrated during the Great War when Indians, particularly in Mesopotamia, were found to suffer equally with Europeans.

Cholera.—Cholera has been since the earliest days of European occupation the most dreaded of all tropical diseases. Its rapid and fatal course and the mystery surrounding its origin have been an ever present and lurking horror. Many of the older clinicians in the pre-microscope days wrote extensively on this dread disease. The most notable work from the laboratory aspect was carried out by Greig who found that the vibrio might lie up in the gall bladder and other recesses of the intestinal canal and that patients who had recovered from the acute stage might remain as carriers to infect a healthy community at some later date. This has been exemplified times without number in connection with the great fairs or pilgrimages which are so striking a feature of Indian life. Carriers of the disease in their pilgrimage from and to their villages may leave a trail of the disease in epidemic form through the country as they pass. This has taxed the sanitarians

to their fullest capacity and elaborate precautions have to be taken by inoculation and other preventive measures to lessen this menace. Rogers has done much valuable work on the clinical aspect of cholera and introduced his well known treatment by hypertonic intravenous saline injections which yields a marked reduction in case mortality. Extensive epidemiological and therapeutic investigations are now going on in India by Russell, Tombs and others which include a large experiment on the prophylactic value of Besredka's "bilivaccine."

Dysentery.—Dysentery both bacterial and protozoal is another disease prevalent amongst all classes of people in India. The epidemics are found to be due almost wholly to the bacterial type (particularly to Shiga's bacillus) whilst the endemic level is chiefly accounted for by the amœbic type. Under this heading are ranged a large number of bowel diseases of varied causation, and much work has been accomplished in trying to unravel the tangled skein of differentiation. Cunningham has endeavoured to sort out the chronic dysenteries and diarrhœas of India, whilst Maitra, Morison, Pai and others have carefully studied local epidemics. Acton and Knowles have written a guide to the differentiation of the dysenteries for practitioners and laboratory workers.

From the clinical and therapeutic aspects Rogers has again left an indelible mark on the progress of our knowledge. Seizing on the laboratory work of Vedder in the Philippines he introduced the use of emetine into the treatment of human amœbic dysentery. This produced a revolution in the treatment of this type of dysentery and is still the sheet anchor amongst methods for curing this formidable disease and its no less formidable complication of liver abscess.

Snake Venom.—In a country like India where poisonous reptiles are so numerous and loss of human life from their bites is so common, it is natural that much attention should be paid to this fascinating subject.

The earlier physicians particularly Patrick Russell, about 1740, and Joseph Fayrer nearly a hundred years later wrote classical monographs on the subject of Indian snakes. Research work into the nature of venoms and their antitoxins was carried out by Lamb who showed that the venoms and their antibodies were almost completely specific. Wall and Rogers have also made valuable contributions to this subject. The anti-venine now produced in India is divalent in potency and contains an anti-viperine and an anti-colubrine antibody. The subject was further studied and additional methods of treatment suggested by Acton and Knowles in 1914. A special remedy for snake-bite in the form of a lancet with potassium permanganate was advocated by Brunton and Rogers and its use obtained a great vogue. The experiments of Bannerman showed that the external application of this chemical failed to avert death after snake-bite and the method has fallen into disuse.

Caius has attempted to concentrate the venom for convenience of administration and he is responsible for the interesting observation that the saliva of non-poisonous snakes is almost equally toxic with the saliva of venomous snakes. The difference between the two classes of reptiles is that one has evolved a hypodermic injecting mechanism of which the other is devoid.

Rabies.—This is another common and deadly disease of India, its frequency being explained by the vast number of ownerless and uncared-for dogs which contract hydrophobia from each other and from jackals and other wild animals in whom it exists in a sub-epidemic or endemic condition.

In 1901 the Pasteur Institute of Kasauli was opened and Semple was its first Director. A continuous stream of good research work has emanated from this Institute since its inception from such investigators as Semple, Harvey, Lamb, MacKendrick and Acton, whilst more recently Stevenson and Cunningham have made further additions to our knowledge.

When this Institute was first opened Pasteur's Dried Cord method was used, then followed the dilution method of Högyes and since 1911 the carbolised method of Semple has been used in this and other Pasteur Institutes of India. A second Institute was opened in Coonoor in Southern India where Cornwall, Pai, La Frenais and others carried on research work into rabies. The Pasteur Institute of Burma was next instituted and latterly others have arisen, in Assam, in Bombay and in Calcutta. The principle has been adopted of manufacturing the vaccine at a given centre and sending it out widely to smaller centres. Thus the vaccine is brought to the people and the delay and anxiety incidental to long train journeys is a thing of the past.

Nutritional Diseases.

Diseases concerned with Nutrition.—In a country like India where a large proportion of the population exists in a condition of chronic economic stress it is not to be wondered at that diseases due to defects in nutrition are widespread. The most extensive and valuable investigation into this class of diseases is to the credit of McCarrison whose previous work on goitre led him into these wider channels of research.

The skein of evidence is still a tangled one and it is slowly being unravelled but as the basis of widespread nutritional deficiency is in reality an economic one these valuable investigations have not yet received the practical application which they deserve. Without attempting to traverse the large volume of McCarrison's work it seems that the most important evidence he has produced is that a nutritional defect need not be serious enough to give rise to actual deficiency diseases like beri-beri, scurvy, rickets and the like but that sub-minimal quantities of vitamin exerting their influence over a period of time may be responsible for chronic ailments particularly intestinal diseases, lowered vitality and even to the mental attributes which we are apt to associate with the

depressed classes and with people living a life of chronic economic stress.

Beri-beri is prevalent in some parts of India and there is the epidemic dropsy of Bengal which has been specially studied by Greig, Acton, Megaw and others. Opinions still differ as to whether this is an infectious disease or a positive or negative nutritional error, i.e., whether it is due to the defect in some accessory food factor or to the absorption of some toxic product arising in one of the articles of food.

Lathyrism is another dietetic disease believed to be due to the presence of contaminated food grains. This has been investigated by Acton, Simonsen, Young and others.

The dietetic problem from the physiological standpoint has been studied, for Bengal particularly, by McCay but we are in ignorance of much which concerns standard dietaries for the other parts of India.

Leprosy.—Fired by his success with the active principle of ipicacuanha in amœbic dysentery Rogers turned his attention to the derivatives of chalmoogra oil, an age-long remedy in the treatment of leprosy. Prolonged trial with the ethyl esters and such like purification products of the crude oil showed that they appeared to be an improvement on the older preparations. The publication of his results even if they did not come up to the standard claimed for them, certainly provided a valuable and much needed stimulus to the study of the disease. The Calcutta Tropical School has in this also led the way and the work of Muir and his associates has much widened our knowledge of Leprosy and has given fresh hope that this formidable and widespread disease may eventually be brought under control.

Previous work by Rost and Williams on treatment by vaccination with a supposed culture of Hansen's bacillus was, like Deycke's work on similar lines, doomed to disappointment. The treatment which gives the greatest chance of success is firstly that directed towards the improvement of the general

health of lepers and the elimination of incidental and associated diseases like malaria and syphilis and secondly the exhibition of chalmoogra oil or its derivatives.

The position is now that although most of the lepers seen about the street and in the asylums are "burnt out" cases beyond the reach of any remedies, the hope for the future lies in the establishment of skin or leper clinics where early cases may be treated and a lasting cure sought for in the rising generation of lepers.

Tuberculosis is a terrible scourge amongst the urban population in India and has received less attention than it deserves. Lankester, Cochrane, Sprawson and Row have studied it in its human aspect whilst Liston, Soparkar and others have added to the knowledge provided by veterinary scientists concerning its prevalence in domestic animals.

Entomology.—In India, this unhappy hunting ground of insect-borne diseases, it is obvious that entomology should be a prominent object of study and the work of the principal investigators in this line has already been referred to under the head of the disease concerned. Mosquitoes, fleas, lice, bugs and flies have been the principal objects of study and just now, in view of its probable causative relation to kala-azar, the sandfly is the fashionable object of investigation. The researches of Christophers and Barraud have perhaps been pre-eminent in the matter of mosquitoes whilst Patton and Cragg have done a large volume of work on insects in general, but in addition to those named elsewhere the younger school of Indian entomologists such as Turkhud, Prasad, Swaminath, Mitter, Awati, Puri and others have done good work on these problems ancilliary to medicine. The insect carriers of malaria, plague, relapsing fever, kala-azar and guinea-worm have all been discovered by investigators in India and that is a record of which any country may be proud.

Helminthology.—The two most widespread and important diseases due to worm parasites are ankylostomiasis and filariasis. A very large amount of work on hookworm disease has been done by Clayton Lane, Mhaskar and Caius, Chandler, Mukerji, Korke, to name the more recent workers. The degree of infestation varies widely in different parts of India and its effects vary accordingly. In some areas the degree of infection is alone sufficient to produce profound anæmia and a high degree of invalidity whereas in individuals and places less severely parasitised, the infection reduces the general level of health sufficiently to allow the inroads of other diseases.

Hookworm infection is one of the diseases which like sub-minimal nutritional defect is responsible for the low level of health, the diminished capacity for work, and the consequent poverty and social degradation which is so sad a feature of many parts of rural and industrial India.

Elephantiasis.—Filariasis is another disease widespread and formidable in its sequelæ. We have already remarked on the fact that the parasitic worm, now called *F. bancrofti,* was discovered by Lewis in India in 1872. Elephantiasis is a serious and crippling disease common in many parts of India. This problem has not received the attention it deserves and much of its pathology is still shrouded in mystery. Lane, Cruickshank, Cunningham, Iyer and others have attacked this difficult problem but much more remains to be done. The question of its prevention is probably bound up with that of malaria, dengue and other mosquito-borne diseases.

Guinea-worm Disease.—A more complete piece of work has been done in Bombay by Turkhud, Liston, Fairley and Soparkar on the guinea-worm disease caused by *Dracunculus medinensis.* This disease which is very prevalent in villages of the Deccan has been shown to be carried by a water flea of the genus Cyclops in which the embryo worm undergoes

development and reaches man by the agency of unfiltered drinking water. The water fleas become infected by the embryos which escape from the lesions on the feet and legs of diseased persons who visit the wells.

Human **schistosomiasis** is not met with in India but animal infections are frequent. A notable monograph on Indian molluscs and their parasites has been written by Annandale and Sewell, whilst valuable researches have been made on *S. spindalis* by Fairley and his assistant Jasudasan.

Vaccine.—Having referred to the principal diseases which have yielded valuable results from the investigations carried out upon them there are one or two other aspects of Medical Research in India which may be briefly mentioned. One of these is **Prophylaxis by Vaccine** and the great advances in the mehods of vaccine production and of the scientific aspects of its application. Haffkine's name stands here pre-eminent, not only because he was the pioneer in India, and one of the world's pioneers, in this branch of specific prophylaxis of disease, but because his work particularly concerns India. His discovery of the plague prophylactic which bears his name has already been mentioned, but he was also the first to produce an anti-cholera vaccine which has now been replaced by one in which the vibrios have been killed by heat. His plague vaccine though substantially the same as it was in his day has nevertheless been the subject of constant study at the Haffkine Institute by a succession of investigators and at the present time researches are being carried on by Naidu and others in an attempt to improve the antigenic power of the vaccine and to lessen the reaction caused by its use.

Much good work on vaccine production for typhoid, cholera and influenza has been done by a succession of workers at the Central Research Institute, Kasauli, particularly by Harvey, Brown and Iyengar, whilst the undue optimism of those investigating the effects of vaccines and other problems of prophylaxis in public health has been kept in check by the

mathematical researches of McKendrick, King and Russell of whom the first named in particular has carried out notable researches in statistical methods.

During the last few years the study of **indigenous drugs** of India has claimed attention and pharmacological laboratories at Calcutta under Chopra and at Bombay under Caius and Mhaskar are carrying out good work on these lines.

Medical **biochemistry** is also beginning to receive attention and there is a well equipped laboratory at the Haffkine Institute where sprue is being investigated on these lines by Sokhey and others.

The Organisation of Research.—Nothing has been said about the organisation which has made all this research possible because this aspect of the question is being dealt with separately under another heading. There have been three factors which have particularly stimulated research. The first was the formation of a separate department which provided a permanent staff for the big laboratories and a security of tenure for those who intended to devote themselves to research. This was at first styled the Bacteriological Department, a title which was recently changed to that of the Medical Research Department. The name of Leslie is particularly associated with this advance. The second was the establishment of the Indian Research Fund Association which provides funds for research, which employs men of good promise from outside the Services, and which initiates, organises and directs researches on such subjects as seem to them the most urgently required. The name of Pardey Lukis deserves special distinction as one of the chief organisers of this valuable association.

The third factor is the establishment of semi-private or state-aided institutions whose foundation and upkeep have been at least in part due to the initiative and generosity of private donors. It is to the Calcutta School of Tropical Medicine that these remarks are particularly applicable for

it was founded and in part supported by the private generosity of Calcutta citizens both British and Indian.

It is to Leonard Rogers, to his energy and to his foresight that this School owes its existence and by its establishment he made his final and his greatest contribution to the cause of medical progress to which he had already devoted so many years of his service in Bengal. This School with its band of devoted workers under the far-seeing direction of Megaw bids fair to rank in the near future as one of the best Schools of Tropical Medicine in the world.

This review of medical research brings us up to the present time and to show that the good work is still going on it will suffice to record the investigations which are being carried on this year under the auspices of the Indian Research Fund Association which has budgeted a sum of over 11 lakhs (£81,485) to meet the expenses of these researches during 1927-28.

These are the conditions which are being specially investigated at the time of writing:—Malaria, Plague, Cholera, Ankylostomiasis, Schistosomiasis, Kala-azar, Leprosy, Nutritional diseases, Tuberculosis, Sprue, Indigenous drugs, Maternal mortality, Dysentery and Diarrhœa, Relapsing fever, Dengue and Sandfly fever, Skin diseases, Diseases of the eye, Rabies, Diabetes, Drug addiction, Vaccines and Bacteriophage. In addition to these enquiries, special grants are made to assist certain institutions in the prosecution of research.

It will be evident to anyone who reads this review that India has played a very distinguished part in the elucidation of tropical diseases and that her efforts have in many cases been crowned with conspicuous success. Thanks to the forward policy of the Indian Research Fund Association there is every reason to believe that the steady output of good and fruitful scientific work is being maintained and we trust that in the future the mantle worn by the distinguished men of the past will fall on shoulders able and worthy to maintain this great tradition.

VIII.

THE PRESENT POSITION OF VETERINARY RESEARCH IN INDIA.

BY

J. T. EDWARDS, B.SC., M.R.C.V.S.,

Director, Imperial Institute of Veterinary Research, Muktesar.

A.—*Results achieved in the principal subjects of research.*

THE results of veterinary endeavours in India have been for the most part essentially practical in character and not of a kind which can be assessed in terms of output of technical publications purporting to convey the results of original research: the approach to the solution of disease problems has been direct (if at times empirical) and the knowledge gained has never been such as would ever admit of being relegated to the limbo of forgotten academic enterprise. The contributions of the early field veterinary workers, in particular, have been of considerable practical utility, and amongst these early endeavours mention may be made of the discovery by *Griffith Evans* of the cause of surra and of the discovery by *Lingard* of the specific affinity of arsenic towards the parasite of surra, the latter discovery marking the beginning of further researches executed in some of the continental laboratories and leading to the formulation of effective methods of treatment against some of the serious human and animal diseases.

The Veterinary Department in India has been in existence for only about forty years, commencing as a Central Department with very small beginnings. Later, with the extension of its work and functions, Provincial Veterinary Departments were formed, containing trained Indian graduates recruited from

the Provincial Veterinary Colleges. The first decided step in the recognition of the importance of research into animal disease was taken by the Government of India in 1890, when it appointed a Special Officer, designated the Imperial Bacteriologist, for the work. The Imperial Bacteriologist had his head-quarters in the first place at Poona, and after two years, in 1893, it was decided to instal a research laboratory at Muktesar in the Kumaon District (7,500 feet), where the conditions of environment were considered ideal for the kind of research contemplated, namely, the investigation of "diseases of domesticated animals in all provinces in India" and finding out "as far as possible, biological research both in the laboratory and, when necessary, at the place of outbreak, the means of preventing and curing such diseases."

For some years the institution remained a relatively small research laboratory, engaged in investigations into the principal diseases of live-stock in India, notably rinderpest, surra bursattee and anthrax. The issue of products to combat diseases was not contemplated until some time after 1893 when the possibilities of serum for use in protecting against rinderpest had been actively explored. Later, in 1900, *Rogers,* while he was acting Imperial Bacteriologist, elaborated the method of protective inoculation by taking cognizance of the finding of *Kolle* and *Turner* (1897) in South Africa, namely, that animals infected naturally, or preferably by inoculation of virulent blood, while they were simultaneously under the influence of the serum, passed through a mild subdued form of the disease, and were thereafter permanently immune. The means were, therefore, discovered of combating the most serious cattle disease in India, either by inoculation with serum alone, useful especially to cut short an outbreak, or by the double inoculation, for the conferment of a permanent immunity upon animals likely to be exposed during their lives to infection.

In the meantime, products were evolved and manufactured on a scale for current issue for combating other serious cattle diseases in the field, with the result that the institution is no

longer the pure research laboratory that it was at its inception, but also a large scale manufacturing undertaking with an organised staff to prepare, with a guarantee as to their reliability, more and newer products for use in the control of diseases of live-stock in India.

The institution has since steadily enlarged the scope of its activities, and, as at present constituted, its functions may be briefly described as follows:—

(1) Manufacture and issue of products—sera, vaccines and agressins—for combating the more serious cattle diseases in India.

(2) Researches into the important diseases that affect live-stock in India.

(3) Collection and identification of entomological and helminthological specimens of veterinary interest. (Work in this direction has been commenced only recently with the provision of suitable staff.)

(4) Examination of morbid material, blood smears, and specimens of parasites of veterinary interest forwarded by Provincial Veterinary Organisations and by the Military Department. This work has now developed into an item of considerable magnitude in the routine activities of the Institute.

(5) Tendering of technical advice to Provincial Veterinary Authorities, Military and other Government Departments and also to private organizations and individuals. (Numerous inquiries are attended to and they cover an extraordinarily wide range of subjects.)

(6) Supply of trained assistants, on request, for the performance of protective inoculation on herds.

(7) Provision of post-graduate training and of short courses in Veterinary Science.

Research Activities.—The Imperial Institute of Veterinary Research differs from other institutions of its kind (e.g., those for research in agriculture and forestry) in the essentially synthetic character of its organization. A spirit of individualism is likely to be accompanied by a lack of appreciation of the

function of this kind of research conducted in this Institute. The various researches in progress have an inherent tendency towards integration and are definitely antagonistic to lonely and superfluous endeavour. It is essential for the officer vested with the control of its activities to perceive clearly their interlacing and inter-dependent qualities so that they may be rendered capable of scientific handling and direction. The task of such an institution is thus necessarily homogenous in that what is required of it is something—in the shape of a material product or a piece of succinct advice—to place at the disposal of the field workers for the ready, effective and practical control of the disease of live-stock in India.

The veterinary problems in India are different in certain fundamental points from those which press themselves for solution in the Western countries. Apart from the prevailing economic conditions which render highly complex the question of the amelioration of the condition of live-stock in India, the peculiarly ethical sentiments that operate to produce in the mind of the average stock-owner a state of inertia in regard to veterinary innovations impart to veterinary problem in India a psychological colour, the significance of which does not quite readily lend itself to the comprehension of an observer who has spent his time entirely among the live-stock of Western countries. Considerations of space preclude an analysis of these economic and psychological factors in their bearing upon the problems connected with the control of diseases of live-stock in India and a passing reference is made to these factors merely to indicate that the "results achieved" by the Veterinary Department in India are, in no small measure, to be appraised by the extent to which it has succeeded in creating public confidence in veterinary methods and ideas generally.

The results achieved at the Muktesar Laboratory in the principal subjects of research resolve themselves into seven well-defined categories:—

(1) *Investigation of conditions under which animals are kept in domestication in India in their bearing upon the elucidation*

of factors responsible for the relative absence of certain diseases in India, as compared with what obtains in the Western countries.—The evidence grows in volume and trustworthiness every year that the virulent germs of tuberculosis do not find the same opportunities for intensive spread among Indian cattle, kept in the open in bright sunlight as they do among European cattle, kept largely in intensive domestication owing to the inclemency of the weather for a large part of the year. This hypothesis has received substantial support from our recent observations at one important Government Military Dairy. From these observations it seems reasonable to conclude that Indian herds which are maintained under a close system of domestication and into which infection has been introduced are exposed to grave danger.

The same remarks apply to what has been observed in regard to the conditions under which contagious bovine abortion prevails in India. Where cattle live in open, in the usual Indian conditions, they are currently infected to the extent of about 10 per cent. but the infection does not become intensified to the extent of causing clinical abortion. On the other hand, where cattle, and particularly indigenous cattle crossed with imported blood, are maintained in somewhat more advanced conditions of domestication, simulating those of the West, the degree of infection, as disclosed by blood tests, sometimes rises to 50 per cent. and in such herds the rate of actual abortion may also rise to 20 per cent., and infected cows may abort several times in succession.

(2) *Survey of animal diseases actually prevalent in India.*—The results of recent researches conducted at the Muktesar Laboratory have thrown light on the significance of certain infections in cattle which have practically escaped the notice of previous veterinary workers in India:—

(*i*) *Coccidiosis.*—Cattle are now known to be infected ubiquitously in India with the protozoan organisms known as coccidia, which multiply ordinarily in

the lining of the bowel very slowly, and cause no manifest disturbance. When the resistance of the bowel lining is depressed, however, as when the animals suffer from rinderpest, the restraints upon the parasites are released and they multiply at such a rate as to cause serious disease and frequently death in the affected animals. The finding has proved of great importance in furnishing us with precise information upon some of the sequelæ that may arise during or following upon attacks of rinderpest.

(ii) *Piroplasmosis.*—Tick-fever or redwater has long been recognised among cattle in India, but the amount of exact knowledge had, until now, been very meagre. We now know that over widespread areas in India cattle become naturally infected with this type of disease by the bites of ticks, when they are very young, at which stage they possess a very high degree of resistance and almost invariably recover from the effects of the infection; they remain thereafter "carriers" of the parasites throughout life, and infect the ticks of the neighbourhood. "Clean" adult cattle imported into such areas such as cattle from districts in India where the disease happens not to exist, or European cattle, succumb readily after they have been bitten by these ticks. These observations are obviously of considerable import in their bearing upon the acclimatization of imported cattle.

(iii) *Johne's Disease.*—This distressing malady has proved to be a serious menace in several important herds in India. After confirmation of its existence in these herds a careful endeavour has been made in some of them to ascertain its incidence, and by the application of special methods

of testing, an incidence rate amounting to 30 per cent. has been disclosed.

(3) *Investigations upon the susceptibility of Indian cattle to certain diseases.*—Investigations upon this type have been particularly conducted with reference to the question of the incidence of bovine tuberculosis in India. It is generally believed that the incidence of tuberculosis infection in Indian cattle is very small (less than three per cent.), whilst in the West the average incidence of infection among cattle amounts to 30 per cent., and the actual loss from the severity of the disease is very high. Results of recent investigations have shown that this low incidence of this disease in India is not attributable to a natural high resistance possessed by Indian cattle (nor to a lower virulence of the germs which cause the disease) but to the comparatively outdoor life of Indian cattle (ante).

(4) *Ætiological Researches.*—Researches under this category have been conducted with special reference to:—

(*i*) *Rinderpest.*—Much precise information has been obtained upon the properties of the infective agent and the factors which determine its virulency under laboratory conditions.

(*ii*) *Strangles.*—This common disease of young horses has formed a major subject for research at Muktesar for the past five years. The causal organism has almost always been identified as the readily recognizable streptococci found in the pus of the sub-maxillary abscesses, though it has been suspected by a few observers that these germs are merely secondary invaders. Knowledge has been obtained confirming this suspicion, and it is most likely that the initial invader is an ultra-visible virus.

(5) *Immunity Researches.*—The results of researches conducted under this head have attained a magnitude which hardly

lends itself to compression within the compass of a memorandum of this kind. In what follows an endeavour will be made merely to indicate the directions along which researches have been conducted and the bearing of the results achieved upon control measures:—

(*i*) *Rinderpest.*—Information has been obtained upon:— the process of immunity; the properties of an anti-serum and the factors that influence its production with a maximum degree of potency; the duration and utility of a passive immunity caused by serum alone; the factors that make for the conference of a permanent immunity by the serum-simultaneous method; the duration of immunity after active immunization; complications (in the form of piroplasmoses and coccidiosis) that may arise in the course of this inoculation and the means of preventing them. As the practical outcome of these researches the Institute has been able to issue, with the rapidly improving technique of manufacture, serum in large quantities and at a price which compares favourably with the prices charged elsewhere.

(*ii*) *Hæmorrhagic Septicæmia.*—The methods previously adopted for the manufacture of anti-serum have now been completely changed. Results of recent investigations have shown that it suffices to inoculate animals initially with adequately large doses of cultures of the specific causal organism, that had become degraded in virulence by artificial cultivation, to obtain within a few days a highly potent serum and thereafter a good serum can be obtained almost indefinitely from them by repeated injections with the same kind of cultures. The serum is therefore now prepared very cheaply from buffaloes that are discontinued from rinderpest serum manufacture.

(*iii*) *Blackquarter.*—The Institute has now undertaken the manufacture of an "aggression" for use against this disease. After issue in the first place on relatively small scale so as to obtain some information upon its efficacy, it has been prepared upon a rapidly increasing scale for practical employment.

(*iv*) *Contagious Bovine Abortion.*—The Muktesar Laboratory was a pioneer in issuing definite printed instructions for vaccination against this disease by cultures of low virulence. In the preparation of the vaccine, use was made of the fundamental knowledge first recognized by this laboratory that the existence of what are termed serologically different types of the germ must be taken into consideration. The vaccine now issued is thus a "polyvalent" one; it is easy of application, without disturbance of the milking programme of a herd.

(*v*) *Contagious Equine Abortion.*—A satisfactory method of vaccination has been evolved, being based upon the knowledge that the immunity following upon the inoculation of dead cultures is necessarily a short-lived one, and that therefore breeding mares have to be vaccinated at intervals throughout the early stages of pregnancy. In the preparation of a vaccine capable of bringing about an almost complete disappearance of abortion it is necessary to incorporate in the vaccine the dead bodies of other organisms which frequently accompany the common causal organism of the disease and which also are capable of inducing abortion.

(*vi*) *Strangles.*—A commencement has been made in treatment with serum from naturally recovered animals, on the assumption that the immune

re-action in the disease may be parallel to that which is understood in the case of rinderpest.

(6) *Ameliorative Researches.*—Researches upon the treatment of the serious disease known as surra (*Trypanosoma evansi* infection) have reached a most satisfactory issue and a memoir embodying the results of the investigations is now in the press. In brief, the simple treatment found to give the most satisfactory result consisted in the administration, simultaneously, intravenously and intrathecally, of the product known as "Bayer 205."

(7) *Miscellaneous.*—A great miscellany of subjects has received attention: for example, improvements in the mode of manufacturing mallein; some diseases of fowls, and especially the common tick-fever of fowls (fowl spirochætosis), its natural mode of transmission and treatment; some sheep diseases, and especially a prevalent contagious pleuro-pneumonia and sheep-pox; kumri—a paralytic disease of horses, which in former years was carefully investigated at Muktesar, with almost completely negative findings; bursattee, which from the histological evidence seems to be a worm infection (habronemiasis) as reported in other countries; laboratory tests for dourine in horses; the common organisms responsible for wound infection (notably the so-called diphtheroids); infectious nasal granuloma of cattle (found to resemble actinomycosis); infectious bovine lymphangitis (a bacillary organism identified as causal agent); mange in buffaloes (life-cycle of sarcoptic parasite worked out, and principle of treatment); certain diseases of fowls and calves; attempts at vaccination of dogs against rabies (at the Lahore, Madras and Calcutta Veterinary Colleges); the fly transmission of surra (at Sohawa).

B.—*Problems now under Investigation in India.*

The reply to this part of the question can be given very briefly by stating that researches into the problems summarily described in the foregoing pages are still under active investigation, to the utmost degree compatible with the facilities at our disposal. Rinderpest still takes a foremost place in our research

projects and every endeavour is made to obtain a simple solution to the problem of its control in India. There are some subjects which now have a diminished importance, particularly those associated with horses, through the diminution in number these animals have suffered in recent years; thus, research into kumri and surra is not economically of the same significance as it was 20 years ago. Research work into animal pathology, at least so far as concerns its major subjects, is a tedious process demanding often steady observation and the accumulation of records for many years for the attainment of economically significant results; hence, it is difficult to foresee under what precise sub-headings researches into the various subjects will be divided in the near future.

Summary.

I. Striking advances have been made in devising satisfactory methods for the control of epizootic and enzootic disease in India.

II. There is, in fact, sufficient laboratory investigation accomplished to bring under control the major contagious or infectious diseases (rinderpest, hæmorrhagic septicæmia, black-quarters, anthrax—and probably piroplasmosis, surra and some other diseases, so far as control is ultimately practicable).

III. The success of applied research into animal pathology has been achieved largely by the propaganda of the field workers in incurring the confidence of animal owners in the efficacy of the artificial methods of control elaborated.

IV. The mass of publications emanating from the Veterinary Department upon research has been small, principally as the kind of applied work upon which the workers are engaged does not lend itself readily to this form of displaying its endeavours.

IX.

AGRICULTURE IN INDIA.

BY

D. CLOUSTON, M.A., D.SC., C.I.E.,

Agricultural Adviser to the Government of India and Director of the Agricultural Research Institute, Pusa.

Agriculture—India's Premier Industry.—Of the industries of India, agriculture is, by far, the most important; it furnishes practically all the material for the food and clothing of the people in urban as well as in rural areas, and provides much of the raw materials for her factories. Three out of every four of the total population of 319 millions depend for their livelihood on agriculture or the industries subsidiary to it. The annual value of the agricultural produce of British India is reckoned to be well over 1,000 millions sterling.

The Indian Peasant.—In India's 700,000 villages the common interest is agriculture and the causes which affect its prosperity. The peasantry, though somewhat improvident in their expenditure on marriages and other social ceremonies, are a people whom to know well is to love. Their patience, high standard of honesty and rustic charm endear them to those who know and understand them. Content with a very low standard of comfort and bound by many ties to their village homes, only a very small percentage of them care to settle down permanently in industrial centres where wages and the standard of living are comparatively high. As pointed out by His Excellency Lord Irwin in a recent speech "the population of India generally is rural rather than urban. The

large town and the industrial centre is the exception; the common feature is the hamlet and the village, and it is in rural life that both in the past and present India has found her most distinct medium of self-expression."

Rural India, Past and Present.—In early times every Indian village was almost self-contained; it not only grew most of its food, but provided either from its own resources, or obtained from close at hand, its few simple wants. Its cloth and often the raw material for it, its bread flour, its sugar, its dyes, its oil for food and lighting, its household vessels and agricultural implements were manufactured or produced either by the cultivator himself, or by the village craftsmen who were members of the village community, and were remunerated by a share of its produce. Money for the payment of Government dues and for the prices of materials of luxury was found by the sale of surplus food grains, or of agricultural and forest products required by neighbouring villages. These exchanges were effected and financed by the country traders, who were found mostly in the large villages or small towns that formed the centres of a series of commercial circles, the radius of each of which was measured by the distance to which the few local imports and exports could be profitably carried by cart or pack bullocks.

Effect of Improved Communications.—In these Arcadian economic conditions the coming of the railway and the steamship, the opening of the Suez Canal, and the extension ot peace and security by the growth of British power effected great changes in course of time. Imnroved communications stimulated the cultivation of crops such as cotton, jute and other fibres, oil-seeds, wheat and tobacco for which there was a demand abroad. They facilitated, too, the introduction of foreign imports and rendered available to the farmer in his distant landlocked village the manufactured products of other lands. Markets sprang up on or near tne railway, where those interested in the export and import trade had their

agencies, and roads connecting up the villages with the railway stations were constructed in increasing numbers. Rural India was for the first time brought into touch with foreign markets and with the fluctuations in the world's prices of commodities in which her cultivators were interested. Improved means of communication, moreover, enabled Government to fight the famines which from time to time visited the land, by carrying by rail to famine-stricken areas the food-stuffs required to tide the cultivator and his cattle over each crisis. The terrible calamities which had depleted wide stretches of country in the past needed no longer to be feared. By stimulating import trade which led to the enormously extended use of woollen cloth and cotton cloth of finer counts, and to the introduction of kerosene oil, matches, soaps, bicycles, sewing machines, motor vehicles, etc., improved communications indirectly added very appreciably to the comfort of the people in rural areas and enabled them to raise their whole standard of living.

As a result of the expansion of her import and export trade, India became more prosperous. Amongst the tests of material progress which can be applied to a country is the growth of its population and the extension of its industries. The population of the Indian Empire, inclusive of Indian States, was 287 millions in 1891; by 1921 it had risen to 319 millions. Within the same period the large textile industries had grown by leaps and bounds; but still more astonishing perhaps was the growth in the production of Indian coal.

Signs of Material Progress.—To the vast increase of Indian agricultural and industrial production and to the enlarged facilities which the State has provided for their distribution, the trade and commerce of India have responded fully. In 1887-88 Indian exports were valued at about 60 millions sterling and imports at 43½ millions. In the year 1913-14 the value of exports had increased to 166 millions,

and of imports to 127 millions. In the year 1923-24 the value of exports had increased to approximately 276 millions sterling and the imports to approximately 188 millions. The mileage of the railways, which have played a social as well as an economic part in the progress of India, by bringing into closer contact populations separated by immense distances and by providing facilities for trade, has been increased from 15,245 miles in 1889 to 38,000 miles in 1924-25. The growth of irrigation, too, has contributed very largely to the material prosperity of the country. Millions of acres of uncultivated lands have been opened up more especially in the Punjab, and colonies of prosperous cultivators settled upon them. In 1891-92 the total area irrigated from Government major and minor works was about 11 million acres; in 1922-23 the area had risen to approximately 28⅓ million acres.

The standard of living among all classes of population, especially among landholders, traders and ryots, has increased very considerably in recent years, and extravagance on occasions of marriage and other social ceremonies has seriously increased. The average villager lives in a better house and eats better food than did his father; brass and other metals have taken the place of coarse earthenware, and the clothing of his family in quality and quantity has improved.

The Climate of India.—The climate of India, while varying to a considerable extent from province to province, has certain well-defined characteristics which are common to all. The monsoon, or rainy season, which extends from June till October is followed by a period of comparatively cold dry weather which in turn is followed by a period of intense heat which extends from March till June. There are two agricultural seasons, namely, the *kharif* or monsoon season and the *rabi* or cold weather season. From the agricultural point of view the most unsatisfactory feature of the rainfall is its liability to failure. Except in irrigated tracts the failure of the rains results in the loss of crops and sometimes in famine.

Government has, therefore, constructed large numbers of irrigation works in tracts where the rainfall is most precarious. The rainfall over India as a whole is very variable; it ranges from 460 inches at Cherrapunji in the Assam Hills to less than 3 inches in Upper Sind. By far the greatest portion of the rain falls during the south-west monsoon between June and October. During the winter months, i.e., from November till February the rainfall is very light, while the hot weather season is practically rainless.

Soils.—For the purpose of soil classification India may be divided into two main areas, namely, (1) the Indo-Gangetic Plains, and (2) Central and Southern India. The physical features of these two divisions are essentially different. The Indo-Gangetic Plains (including the Punjab, Sind, the United Provinces, Bengal, Bihar and Assam) form large level stretches of alluvium of great depth and natural fertility. Central and Southern India, on the other hand, consists of hills and valleys. On the higher lands shallow gravelly soils of lateritic origin are common, while on the lower ground clayey loams predominate. These loams are sticky in the rains, hard and crumbly in the dry weather and very retentive of moisture.

Agricultural Capital and Equipment.—India is a country of small holdings; the tenant farmer is the backbone of the agricultural population of which he constitutes by far the largest section. Farming is carried on with a minimum of capital; the outlay on fencing buildings and implements is exceptionally small. Very few of the larger landowners take a practical interest in agriculture. They live in the towns and leave the management of their estates to subordinates. Their apathy is one of the chief obstacles to progress in rural development.

Disposal of Produce.—The marketing of agricultural produce is not yet organised, no attempt is made to grade

produce for the market. The cultivator has, as a rule, to dispose of the bulk of his crops soon after they are harvested in order to pay his rent and meet his miscellaneous expenditure. He is sometimes so heavily in debt that he has to hand over part of the produce of his fields to the village money-lender. Of the 260 million acres sown with crops in British India the area irrigated from canals, tanks and wells is just over 50 million acres. Eighty per cent. of the total cropped area is under food-crops, nearly six per cent. under oil-seeds and about eight per cent. under fibres. In 1925-26 India produced 30,572,000 tons of rice, 8,704,000 tons of wheat, 15,628,000 tons of other food-crops including barley, maize, millets and gram, 3,856,000 tons of oil-seeds including linseed, mustard, rape, sesamum, castor and groundnut, 2,930,000 tons of raw sugar (*gur*), 6,075,000 bales of cotton and 10,839,000 bales of jute. In the same year she produced 363,506,000 lbs. of tea, 22,106,000 lbs. of coffee, 19,970,000 lbs. of rubber and 3,024,000 lbs. of indigo. Eight per cent. of the total yield of rice, three per cent. of that of wheat, ninety per cent. of that of tea, sixty-nine per cent. of that of cotton, forty-six per cent. of that of raw jute and seventy-seven per cent. of that of linseed were available for export.

The Organisation of Agricultural Departments and Institutions.—The considerable strides made before the beginning of the present century in providing facilities for irrigation and an outlet for agricultural produce had admittedly contributed largely to the material prosperity of the country generally. In spite of the rapid growth of commerce and improvements in communications, the economic condition of the peasantry did not improve to the extent that was hoped. This was, partly at least, due to the fact that little had been done by the State to increase the agricultural output by means of agricultural education, better varieties of seed, greater diffusion of good stock, improved manuring and tillage, etc. Leaving aside spasmodic efforts made by the

East India Company and the Government of India on isolated occasions for special purposes, the policy of creating a special Department to investigate the general conditions of agriculture was first recommended by the Commission appointed to enquire into the Bengal and Orissa famine in 1866. This resulted in a scheme for the formation of a new Department "to take cognisance of all matters affecting the practical improvement and development of the agricultural resources of the country, which should consist of a separate Department under the control of an official Director in each Province, upon whom would devolve the real work of studying and improving agriculture." There was also to be a Central Imperial Department of the Government of India " to guide and control the work of the Provincial Departments." Provincial Departments of Agriculture were formed but for a time they were handicapped by the fact that they were not given an expert staff. Towards the end of the last century there was a great revival in agriculture science in England and even in India there were indications of keenness for agricultural research before the facilities for giving effect to it became available. The Imperial Department of Agriculture in India may be said to date from 1901, when the Government of India appointed an Inspector-General of Agriculture with a view to the more active prosecution of a policy of scientific and practical investigation into agricultural matters. The policy of the late Lord Curzon, who was Viceroy at this time, was to increase the prosperity of agriculture and to secure the fullest possible use of the land. An Imperial Department of Agriculture was created and a Research Institute was opened at Pusa in Bihar and Orissa. Combined agricultural colleges and research institutes were established in the provinces and research and propaganda work started. For the investigation, prevention and control of cattle diseases an Imperial Institute of Veterinary Research was opened at Muktesar and Veterinary Departments were created in the provinces.

Prior to 1921, the policy of agricultural development in India as a whole was guided by the Government of India, but with the inception of the Reforms in 1921, agriculture became a transferred subject and Provincial Governments were granted autonomy in respect of the policy of agricultural development in their provinces. The Central Government, however, still concerns itself with agricultural problems of all-India importance and maintains the following institutions under the administrative control of the Agricultural Adviser to the Government of India:—

No.	Name of Institute.	Aims and object of the Institute.
1.	Agricultural Research Institute, Pusa.	Fundamental research and post-graduate training in general agriculture, plant breeding, agricultural chemistry, mycology, entomology and agricultural bacteriology.
2.	Imperial Institute of Veterinary Research, Muktesar.	Research in animal diseases, manufacture of sera and vaccines and training in veterinary technique.
3.	Imperial Institute of Animal Husbandry and Dairying, Bangalore.	
4.	Imperial Institute of Animal Husbandry and Dairying, Wellington.	Investigation and training in subjects relating to cattle breeding, dairying and animal nutrition.
5.	Cattle Breeding Farm, Karnal.	
6.	Anand Creamery.	
7.	Sugarcane Breeding Station, Coimbatore.	Breeding of new seeding canes.
8.	Sugar Bureau, Pusa. ..	Collection and dissemination of information on the sugar industry.

There are combined agricultural colleges and research institutes at Cawnpore (United Provinces), Lyallpur (Punjab), Poona (Bombay Presidency), Coimbatore (Madras Presidency), Nagpur (Central Provinces), and Mandalay (Burma).

The remaining four provinces have got only research laboratories.

Besides Government Departments, there are two semi-Government institutions which carry out agricultural and technological research. The one is the Indian Central Cotton Committee, Bombay, which is a corporate body charged with the promotion of all measures which will tend to further the improvement of the cotton growing industry. It has funds of its own got from the Indian Cotton Cess. The other is the Institute of Plant Industry at Indore established in 1924 for the study of cotton and other crops.

The following private organizations have got scientific departments to carry out researches on plantation crops in which they are interested:—

(a) Indian Tea Association (Research Station at Tocklai, P. O. Cinnamara, Assam).
(b) United Planters' Association of South India.
(c) Indian Lac Association (Research Station at Ranchi).

Some of the major Indian States, e.g., Mysore, Travancore and Baroda maintain small agricultural departments of their own.

Economic Work on Crops.—The Indian cultivator is essentially a grower of crops, but he rarely devotes any attention to the selection of seed. Seed merchants in the European sense do not exist in India and the Departments of Agriculture have, therefore, had to play, on a considerable scale, the part of seed merchants. They have evolved improved varieties and strains by selection and cross-breeding, propagated the seed of these improved varieties and built up an organization for their distribution. The area sown with improved seed last year is reckoned to have exceeded 7 million acres. The want of attention in the past to the variety and quality of the seed sown has resulted in a low level of production and a lack of uniformity in the produce. By the

introduction of pure strains of seed evolved by the Department of Agriculture, the acreage yield has been increased and the quality improved. Of the crops improved by the Department, cotton, wheat, rice, sugarcane, groundnut, tobacco and jute are the most important.

The interests of Indian growers and spinners alike demand that a larger portion of the cotton produced in the country should be of a type generally acceptable to the cotton spinners of the world. The aim of the Department has, therefore, been to improve the quality of the lint as regards staple and grade. A great measure of success has been achieved in this direction, and the improved strains introduced were, in 1925-26, sown in an area of over three million acres, which represent nearly 12 per cent. of the total area under cotton. The development of the cotton industry in India owes much to the Indian Central Cotton Committee which has done much to co-ordinate research work on cotton, to check adulteration, and to improve marketing facilities.

One of the most successful pieces of work on wheat improvement has been the isolation of higher yielding and rust-resisting varieties of good milling and baking qualities. The area of improved wheats now under cultivation is about 2 million acres.

India is the largest exporter of rice in the world; three-fourths of the rice exported are contributed by Burma where the department has selected varieties to meet the special requirements of the foreign market.

Although sugarcane is grown on an area of about 2¾ million acres, India was obliged last year to import over 700,000 tons of white sugar, at a cost of 10 million sterling. The necessity of importing such a large quantity of sugar is partly due to the fact that the average yield of the canes cultivated in India is probably the lowest in the world. The hope of effecting an improvement in outturn has received

a remarkable stimulus from the work of the Imperial Cane-breeding Station at Coimbatore. At this station entirely new varieties have been bred which have in some tracts given twice the yield ordinarily obtained from the local varieties grown under exactly similar conditions. Moreover, varieties have been evolved which are suitable for varying conditions of soil and climate.

In the yield of tea great improvement has been effected by the expert staff employed by the Indian Tea Association.

The introduction of early-maturing varieties of high oil-content has led to a rapid extension of groundnut cultivation in certain provinces. The area of nearly four million acres now under this crop is more than double that of 7 years ago.

As regards tobacco the position is that while India imports 8½ million lbs. at a cost of 1½ million sterling, the 38 million lbs. exported fetch only about ¾ of a million sterling. This is due to the fact that indigenous varieties cultivated give a somewhat coarse leaf of poor quality. If a tobacco possessing the colour, flavour and texture of that which is commonly called Virginian can be grown and cured in India, there is every possibility of building up an export trade with Great Britain and of meeting, at the same time, the local demand for a tobacco of this quality. Some of the American tobaccos now under trial have given promising results: crosses between them and indigenous varieties are under trial at Pusa.

In the production of jute India enjoys a monopoly. To the improvement of this crop much attention has been given in Bengal where the bulk of the jute produced in India is grown. Strains have been selected which give considerably larger yields than the varieties commonly grown; of these strains large quantities of seed are now being given out to the growers.

Cattle-breeding.—In Indian Agriculture cattle should play a larger part than they do in most countries, for the ox is

the draught animal used on the farms, and milk is one of the most highly prized foods consumed by the people. Cattle-breeding and dairying have, nevertheless, been neglected in the past to a greater extent than any other important branch of husbandry. It does not pay to rear cattle purely for draught purposes except in backward tracts where grazing is plentiful. In the more prosperous tracts, the cultivator finds it cheaper to buy than to rear the bullocks: he keeps she-buffaloes to supply him with milk. The Imperial and Provincial Departments of Agriculture are devoting considerable attention to the improvement by selection and better feeding of breeds, the males of which possess good draught qualities and the females useful milking qualities.

With a view to producing still more profitable dairy cattle the cows of the dual-purpose breeds kept on some of the Government farms are being crossed with imported Ayrshire and Holstein bulls with the object of producing first class dairy cows. The extent to which the milking capacity of cows has been increased by selection and mating with such bulls may be gathered from the fact that while an average village cow of a non-milch breed gives about 800 lbs. of milk in a lactation period and an average cow of a milch breed about 2,000 lbs., improved cows on Government farms are now giving up to 7,000 lbs. and cross-bred cows up to 12,000 in a lactation period.

The Agricultural Departments are also devoting a good deal of attention to the cultivation and storage of fodder crops. In the past the cultivator used to depend on grazing areas for the provision of food for his cattle, but the ever-increasing pressure on the land has brought about a reduction of such areas and the consequent necessity for growing fodder crops for cattle.

Veterinary Work.—In India cattle diseases are rampant; of these rinderpest is by far the most formidable. Progress has been made by the Veterinary Department in devising

satisfactory methods of controlling this and other diseases by means of inoculation. The serum used is produced at the Imperial Institute of Veterinary Research at Muktesar.

Tillage and Manuring.—The Indian cultivator possesses a fairly intimate though limited knowledge of the main essentials of his own business. The implements he uses are simple and inexpensive but they are not very efficient. The principal implements used for tillage are the wooden plough and the clod crusher. The plough is defective in so far as it merely stirs the soil without inverting it. Crops are cut by the sickle and threshing is done by cattle treading out the grain. Irrigation water is raised by man-power where the lift is small, in other cases by bullocks. Though much of the cultivated land in India is naturally fertile, the soil over large areas has been impoverished as a result of its being cropped year after year without manure. Various kinds of natural and artificial manures have been tested on Government farms and a small demand for them created by demonstrating their use in villages. The demand for fertilizers is on the increase. In 1925-26, 42,159 tons of fertilizers were imported into India by sea as against 7,414 tons five years ago. A large proportion of the fertilizers used goes to tea and coffee plantations, but larger quantities are now being applied also to such valuable crops as sugarcane, cotton and tobacco.

Agricultural Implements and Machinery.—It is held by engineers well-acquainted with agricultural conditions in India that the development of agriculture is likely to be of a very restricted character in this country unless it connotes the application of the resources of mechanical engineering to the tilling of the soil, the supply of irrigation water, the harvesting of the crops, their transport to factories and to the machinery for converting them into finished, or at any rate, easily marketable products. In India we are now at the transition stage between manual and mechanical power on the farm. The relatively low standard of cultivation attained in India is largely the result of

the inefficiency of the country (*deshi*) plough; this plough, inefficient though it is, is used for several operations for each of which special implements are used in more advanced countries. The improved iron ploughs now in use in India are the handiwork of engineers who have devoted much time and thought to their evolution. The obstacles in the way of introducing them on a large scale are the initial cost and the inefficiency of the bullock as a draught animal; still an ever-increasing demand for such ploughs has already been created. There is already a large demand in India, too, for iron cane mills and some demand for power pumps, winnowers, reaping machines, fodder cutters, threshers, hoes and harrows. It is believed that within the next 20 years the demand for improved implements required for the better cultivation of the land will be enormous; the annual demand for ploughs alone may run into hundreds of thousands. The demand, too, for motor vehicles for transport purposes is likely to increase very rapidly. To foster and stimulate the existing demand the Departments of Agriculture are already doing a good deal. They are demonstrating the working of approved implements and machines in the villages. They display them at agricultural shows and ploughing matches. They stock them for sale and in some cases for hire at depôts on Government farms. They are organising their sale through co-operative societies, and in some provinces they are giving pecuniary assistance in the shape of *taccavi* (Government loans) for their purchase.

Agricultural Education.—There are six agricultural colleges in the provinces, but very few of the students who seek admission to these colleges do so with a view to taking up farming. The bulk of those trained so far have been provided for in the agricultural services of their province and any diminution in recruitment to the services in a province is at once reflected in a decline in the number of candidates for admission to the agricultural college. This is due to the fact that the outside demand for trained men is small, the rural

areas are backward educationally and the average landowner takes but little interest in the practical side of agriculture.

Most of the education given in primary and middle schools in rural areas, is, unfortunately, unsuitable from the cultivator's point of view. It tends to alienate the sympathy of the pupil from the land and to unfit him for farming as a vocation. It is divorced from practice. Experiments in adapting education in rural schools to rural needs, have within the last seven years been made in two or three provinces, but more especially in the Punjab where agriculture has been added to the curriculum of rural middle schools with the aim of giving the boys a bias towards farming as an occupation. The object in view is to give the boys an intelligent outlook on rural life, and to interest them in agriculture and its possibilities.

In some provinces special agricultural schools have been opened for boys of from 13 to 14 years of age. These schools aim definitely at training boys in the theory and practice of agriculture; they are in short, vocational in character.

Agricultural Co-operation.—Agriculture in India like every other industry requires a constant infusion of new capital, but unlike most other industries it is not in a position to appeal to the public for its requirements. At the same time its need is greater because the industry, broadly speaking, is much under-capitalised. Considerable progress has been made in the provinces in providing better credit facilities for the cultivator, but little has been done to establish co-operative societies for the marketing of agricultural produce and for the purchase and supply of agricultural requisites. In most provinces the relationship between the agricultural and co-operative departments is becoming increasingly close but it is not yet as close as it ought to be.

X.

IRRIGATION IN INDIA.*

Meteorological Conditions and Rainfall.—No review of irrigation in India, however brief, would be complete without some reference to the meteorological conditions which render such irrigation necessary.

The chief characteristics of the Indian rainfall are its unequal distribution over the country, its irregular distribution throughout the seasons and its liability to failure or serious deficiency. The normal annual rainfall varies from 460 inches at Cherrapunji in the Assam hills to less than three inches in Upper Sind. The greatest rainfall actually measured at any station in any one year was 905 inches, recorded at Cherrapunji in 1861, while at stations in Upper Sind it has been nil. There are thus portions of the country which suffer as much from excessive rainfall as others do from drought.

The second important characteristic of the rainfall is its unequal distribution throughout the seasons. Except in the south-east of the peninsula, where the heaviest precipitation is received from October to December, by far the greater portion of the rain falls during the south-west monsoon, between June and October. During the winter months the rainfall is comparatively small, the normal amount varying from half an inch to two inches, while the hot weather, from March to May or June, is practically rainless. Consequently it happens that in one season of the year the greater part of

* Abstracted from the Triennial Reviews of Irrigation in India, published by the Government of India. The Review for 1918—1921 gives a full account of the subject.

India is deluged with rain and is the scene of most wonderful and rapid growth of vegetation; in another period the same tract becomes a dreary, sunburnt waste.

But from the agricultural point of view undoubtedly the most unsatisfactory feature of the Indian rainfall is its liability to failure or serious deficiency. The average annual rainfall over the whole country is about 45 inches and there is but little variation from this average from year to year, the greatest recorded being only about seven inches. But if separate tracts are considered, extraordinary variations are found. At many stations annual rainfalls of less than half the average are not uncommon, while at some less than a quarter of the normal amount has been recorded in a year of extreme drought.

The effect of these variations, as productive of famine and scarcity, differs considerably according to the average rainfall of the tract, being least in those parts where the average is either very high or very low. Where the average rainfall is high, a large deficiency can be experienced and yet sufficient water remains to ensure successful agriculture; where the average is very low, ten inches or less, cultivation without irrigation and agriculture consequently ceases to depend upon the rainfall and relies wholly upon water obtained from other sources. In portions of such tracts which are devoted to pasturing cattle, high prices or the drying up of the natural grasses may lead to distress, but famine from failure of crops need not be apprehended. But between these extremes, in which the crops are rendered safe either by an assured and abundant rainfall or by exclusive reliance upon irrigation, there lies a vast area, in which the average rainfall varies between 75 and 10 inches, no portion of which can be deemed absolutely secure against the uncertainties of the season and the scourge of famine.

Frequency of Years of Scarcity.—Classing a year in which the deficiency is 25 per cent. as a dry year and one in which

it is 40 per cent. as a year of severe drought, the examination of past statistics shows that, over the precarious area, one year in five may be expected to be dry year and one in ten a year of severe drought. It is largely in order to remove the menace of these years that the great irrigation systems of India have been constructed.

The Precarious Area.—In general it has been found that the lower the rainfall in a tract, the greater is its liability to serious deficiency from the average, and the most precarious area is that in which the normal rainfall is less than 50 inches. This area includes practically the whole of the Punjab and the North West Frontier Province, the United Provinces except the sub-montane districts, Sind, a large portion of Bihar, most of Madras, most of the Bombay Presidency except a strip along the coast, portions of the Central Porvinces and a small tract in Burma. It is in this area that the principal irrigation works in India are to be found.

Water Supply.—There are, however, other factors which govern the introduction of irrigation, the most important being an adequate water supply. The high-lying rocky plateau, which forms the interior of the peninsula, is very unfavourably situated in this respect, having an uncertain rainfall, rivers which, for much of the year, are nearly dry, a scanty population and but little agriculture as compared with that which flourishes in the alluvial tracts. Something has been done, by the construction of reservoirs, to conserve the monsoon rainfall and extend its benefits over the other seasons of the year, but by far the greater portion of the central plateau must, for want of water, remain for ever unirrigated.

The Government irrigation works of India may be divided into two main classes, those provided with artificial storage, and those dependent throughout the year on the natural supplies of the rivers from which they have their origin.

Storage Works.—The expedient of storing water in the monsoon for utilization during the subsequent dry weather has been practised in India from time immemorial. In their simplest form, such storage works consist of an earthen embankment constructed across a valley or depression, behind which the water collects, and those under Government control range from small tanks irrigating only a few acres each to the huge reservoirs now under construction in the Deccan which will be capable of storing over 20,000 million cubic feet of water. By gradually allowing water to escape from a work of the latter type, a supply can be maintained long after the river on which the reservoir is situated would otherwise be dry and useless.

Non-storage Works.—In actual fact, practically every irrigation work depends upon storage of one kind or another but, in many cases, this is provided by nature without man's assistance. In Northern India, the snowfields and glaciers of the Himalayas hold up water on a scale which man cannot hope to rival. The storage afforded by soil absorption is, of course, very limited and consequently, throughout the peninsula proper, artificial storage is necessary if a continuous supply of water is to be assured, except in the case of the very largest rivers where the catchments are so great that the drainage from them is sufficient to maintain a supply, albeit usually a very meagre one throughout the year. Thus, for example, the Kistna, which drains nearly 100,000 square miles of country and discharges in flood time one and a quarter million cubic feet of water a second, dwindles during the hot weather to a small stream, winding among sandbanks and carrying a quite inconsiderable volume. It is consequently in Northern India, upon the Himalayan rivers, and in Madras, where the cold weather rains are even heavier than those of the south-west monsoon, that the principal non-storage systems are found.

Perennial and Inundation Canals.—The canals which rely solely upon the natural flow of the rivers for their supplies may

be divided into two main types, perennial canals and inundation canals. Perennial canals are provided with some arrangement in the vicinity of their heads, usually in the form of an obstruction across the bed of the parent stream, by means of which they are enabled to obtain their supplies irrespective of the level of the water in the river. The water is, by means of this obstruction, ponded up to the height required in the canal, and seasonal fluctuations in the water level in the river are thus counteracted. The obstruction usually takes the form of a weir or barrage fitted with shutters and sluices whereby surplus water, not needed in the canal, can be escaped down the river.

Inundation Canals.—Inundation Canals, on the contrary, have no such weirs and their supplies fluctuate with the natural water level in the river. When this rises, the level in the canal rises, when it falls, the level in the canal falls with it. Generally speaking, inundation canals obtain a supply only when the parent stream is in flood and the adequacy or otherwise of this supply, and therewith the area irrigable in the year in question, is consequently solely dependent upon the seasonal conditions. There may be an ample volume in the river but, in the absence of any method of raising its level, it cannot be forced into the canal until the water rises, of its own accord, to a sufficient height.

It may possibly be asked why, in view of the advantages to be obtained thereby, all canals have not been made perennial. The answer is: expense. The majority of and by far the most important inundation canals are to be found in Sind and the Punjab on the Indus and Sutlej rivers. The task of harnessing these great rivers has not yet been taken in hand, it is now proposed to construct a barrage across the Indus, at a cost of Rs. 569 lakhs, and four across the Sutlej at a cost of Rs. 384 lakhs, and by linking up a number of the existing inundation canals to each barrage, to afford to them an assured and controlled supply. It is fully recognised that

inundation irrigation cannot be regarded as other than an inefficient substitute for perennial irrigation and steps are now being taken, wherever possible to supersede it by the latter class.

Productive, Protective and Minor Works.—For the purpose of determining the source from which the funds for the construction of Government works are provided, they are divided into three classes, productive, protective, and minor works. Of these only productive works might, under the rules in force up to the end of the triennium, be financed from loans. The main criterion to be satisfied before a work can be classed as productive is that it shall, within ten years of the completion of construction, produce sufficient revenue to cover its working expenses and the interest charges on its capital cost. Most of the largest irrigation systems in India belong to the productive class.

Protective works are constructed primarily with a view to the protection of precarious tracts and to guard against the necessity for periodical expenditure on the relief of the population in times of famine.

It is difficult to define the class of minor works otherwise than by saying that works not classified either as productive or protective are classified as minor works. They include many of the inundation canals which take off from the Indus and its tributaries in the Punjab and Sind, some of them being of very considerable size and importance, a number of old irrigation works and flood protective embankments in Burma, many small tanks, storage reservoirs and canals or groups of canals scattered throughout the country and lastly, and collectively the most important, some 47,000 minor tanks and petty irrigation works in the Madras Presidency. Nearly a third of the whole area irrigated in India from Government works is effected by these minor works.

There has, during the last forty years, been a steady growth in the area irrigated by Government irrigation works.

From 10½ million acres in 1878-79 the area annually irrigated rose to 19¼ million acres at the beginning of the century and to 28¼ million acres in 1922-23, the record year up to date, from which figure it fell again to 26½ million acres in 1923-24. The main increase has been in the class of productive works, which irrigated 4½ million acres in 1878-79, 10 million acres in 1900-01 and 18¾ million acres in 1919-20. The area irrigated by the protective works has increased, in the same period, from nil to over three quarters of a million acres, that by minor works from 6 million to 8½ million acres.

Future Development.—Some idea of the probable future development of irrigation can be obtained from the forecasts appended to the project estimate of the works now under construction and awaiting sanction. The area irrigated in 1922-23 was, as has already been stated, over 28¼ million acres. Schemes completed but which have not yet reached their full development are expected to add about 100,000 acres to this total while works under construction will further enhance it by 2½ million acres. Projects have also been submitted to the Secretary of State for sanction which, if constructed, will add another 4¾ million acres; a total eventual area in British India of about 36 million acres is thus at present contemplated from works sanctioned or awaiting sanction, irrespective of the natural extension of existing areas and of new projects, of which several are under construction, which may be put forward in future.

The figures given above are exclusive of the areas irrigated from the Punjab canals by branches constructed for Indian States, which amounted in 1919-20 to 650,000 acres. The Sutlej Valley Project will add nearly 3¼ million acres to this area, so that a gross total of some 40 million acres from Government works is confidently looked to.

Mileage of Channels.—Perhaps, however, the easiest way of visualizing the growth of irrigation is by reference to the

mileage of channels. In 1900-01, 39,142 miles of Government channels were in operation; by 1920-21 this length had increased to 55,202 miles, a length more than sufficient to girdle the earth twice. This connotes an average addition of about 800 miles of channels every year.

Financial Returns.—Finally, the general financial returns may be looked at. The total capital invested in the works has arisen from Rs. 4,236 lakhs in 1900-01 to Rs. 7,861 lakhs in 1920-21, an average increase of Rs. 180 lakhs a year. As regards revenue, the Government irrigation works in India, taken as a whole, yield a return of from 7 to 8 per cent. on the capital invested in them; this is a satisfactory result as Rs. 1,173 lakhs of the total have been spent on protective works, which return less than 1 per cent. and Rs. 703 lakhs on minor works, the yield from which varies between 4 and 6 per cent. The capital outlay also includes expenditure on a number of large works under construction, which have not yet commenced to earn revenue. It follows that, besides increasing the yield of the crops, making agriculture possible in tracts where, without an assured supply of water, nothing would grow and protecting large areas from famine and scarcity, the irrigation works of India form also a remunerative investment for the funds sunk in them.

Brief Mention of Projects.—The practice of drawing off the flood waters of the Indus for the irrigation of Sind and parts of the western Punjab has been followed from a very early date. In the sub-montane districts of northern India are sometimes to be found vestiges of ancient irrigating channels which have been buried for centuries in the undergrowth of the forests. There are also a certain number of old indigenous tanks and river works in Burma. Little, however, was done in the construction of large works before the country came under British rule. There are, however, exceptions the most notable being the Grand Anicut across the Cauvery in Madras,

two canals from the Jumna which were the origin of the present Western and Eastern Jumna canals and the Hasli canal from the Ravi which has been replaced by the Upper Bari Doab Canal.

Early engineering works under the British chiefly took the form of improvements of these existing works. The Cauvery Delta system was taken in hand in 1836 and now irrigates over one million acres in the district of Tanjore. The Western Jumna canal was remodelled in 1873; it now has 2,000 miles of main canals and irrigates nearly a million acres. The Eastern Jumna canal also reconstructed irrigates about 400,000 acres of the Doab (land between the Jumna and Ganges).

Since these days innumerable new canals have been constructed, many of them projects of the greatest magnitude. Even the large systems are too numerous for even the briefest description in the space here available, but some may be mentioned.

In the Ganges Valley are the Ganges Canal (one million and a half acres), the Lower Ganges Canal (over one million acres), the Agra Canal, the Sarda Canal, the Oudh Canal and many smaller systems.

In the Punjab are the western Jumna (819,000), the Upper Bari Doab (over one million), the Sirhind Canal (1,700,000 acres), the Lower Chenab (2,395,000 acres), the Sidhnai, Lower Jhelum, Upper Sutlej and the Triple Canals Project. The last mentioned is a gigantic work which carries the surplus water of the Jhelum River first into the Chenab River, from thence to a level crossing over the Ravi River and finally into the Lower Bari Doab Canal. It commands 3,997,000 acres or 6,250 square miles. These great systems in the Punjab do not merely irrigate land already under cultivation but convert almost uninhabited tracts into the so-called Internal or Canal Colonies.

In Sind are the Desert, Unharwah, Begari canals on the right bank, and the Eastern Nara, Jamrao, Sukker Canals and others on the left bank.

In Bombay irrigation has largely taken the form of artificial storage. The Mutha Canal at Poona was the first canal in India with a high dam. The reservoir is Lake Fife (named after Col. Fife, the Engineer) which is six square miles in area and stores 4,000 million cubic feet of water. A similar project is the Chaukapur Tank in which the dam is 140 feet high. The Bhandardara Dam is 270 feet high and creates Lake Arthur Hill which has a capacity of 10,800 million cubic feet.

In Madras great developments in irrigation have taken place. Besides the Cauvery is the Godaveri Delta System which has 2,000 miles of distributaries and irrigates about one million acres. On this system is the Gunnaram Aqueduct carrying the canal over a branch of the Godaveri. The aqueduct is of 49 spans, each of 40 feet water-way carrying a channel 24 feet wide. The Kistna Delta system takes off at Bezwada and irrigates 700,000 acres. The Peryar system diverts a large river which would normally flow into the Arabian Sea into an entirely different drainage basin. This is accomplished by a dam, the Peryar Dam, 173 feet in height and a tunnel to take the water across the watershed. The Peryar Lake formed by the dam holds 15,661 million cubic feet, of which 9,176 can be used for irrigation.

Attached are tables giving the areas irrigated by Government works in the different provinces. As regards the Punjab there is nothing to approach it anywhere in the world.

Statement showing the acreage of crops matured in British India during 1923-24 by means of Government Irrigation systems is compared with the total area under cultivation in the several provinces.

Province.	Net area cropped.	Area irrigated by Government irrigation works.	Percentage of area irrigated to total cropped area.	Capital cost of Government irrigation and navigation works to end of 1923–24. (In lakhs of rupees).	Estimated value of crops raised on areas receiving State irrigation. (In lakhs of rupees).
Madras	36,424,000	6,891,000	18·9	1,207	* 3,556
Bombay-Deccan	39,000,000	418,000	1·0	881	538
Sind	4,134,000	3,427,000	82·9	479	1,054
Bengal	22,806,000	93,000	0·4	422	78
United Provinces	35,011,000	1,979,000	5·7	1,577	1,348
Punjab	26,731,000	10,207,000	38·2	2,543	5,505
Burma	13,857,000	1,730,000	12·5	363	812
Bihar and Orissa ..	24,665,000	954,000	3·9	627	622
Central Provinces ..	17,427,000	438,000	2·5	483	281
North-West Frontier Province	2,593,000	359,000	13·8	276	226
Rajputana	281,000	16,000	5·8	35	5
Baluchistan	286,000	26,000	9·0	32	5
TOTAL ..	223,215,000	26,538,000	11·9	8,925	14,030

* Exclusive of the value of crops raised on some 3 million acres irrigated by non-capital works.

XI.

ARCHÆOLOGY.

A COMPLETE account, even in abstract, of the Archæology of India cannot here be given, but some help and guidance to the stranger to India may be contained in the following references to some of the more obvious Archæological features of India. A reference to the brief history of India given in Section II will explain many of the terms used such as Mauryan, Gupta, Moghul, etc. Knowledge of the pre-historic Chalcolithic period of India is entirely recent.

Chalcolithic Age.—It was formerly believed that no building or architectural remains in India were much older than the period of the Mauryan Empire (300 B.C.). Recent investigations by the Archæological Department of the Government of India under Sir John Marshall have, however, brought to light buried cities and a civilisation of an antiquity equal to those of Egypt and Babylonia. These evidences relate to what is known as the *Chalcolithic age* (*Copper-stone Culture*). Evidences of the Chalcolithic culture are known from a wide area including, besides the recently discovered evidences in north India, Egypt, Syria, Palestine, Thrace, Asia Minor, Mesopotamia, Persia, Baluchistan and Transcaspia. Formerly the prehistoric civilisation on the Indus, owing to its close connection with the Sumerian civilisation of Mesopotamia was termed "Indo-Sumerian." But though certain features exist in common it is now considered by Sir John Marshall that these indicate only intimate commercial or other intercourse and that the "Indus" civilisation was distinct.

The "Indus" civilisation is known to have extended over Baluchistan and Waziristan, as well as over Sind and the Punjab, and there is evidence to show that it also extended eastwards

over Cutch and Kathiawar towards the Deccan. That there was a contemporary civilisation on the banks of the Ganges is considered by Sir John Marshall almost certain, but it is hardly probable he thinks that this was of precisely the same character as that on the Indus.

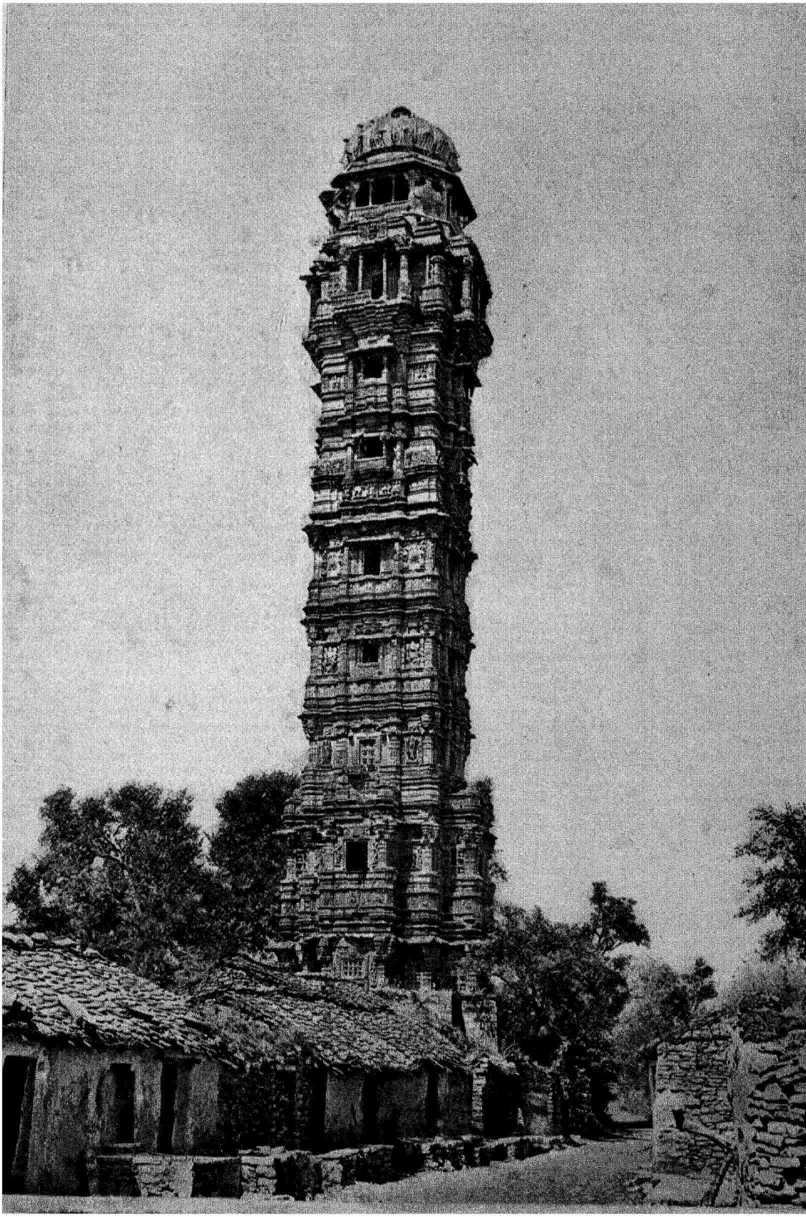
The most important excavations of the " Indus " civilisation are at Mohenjo-daro on the Indus and at Harappa in the Punjab. Mohenjo-daro is between 4 and 5 miles from the present bank of the Indus and 8 miles from the railway station of Dokri in the Larkana District of Upper Sind. The mounds embrace an area of 250 acres, but parts of the older cities must be below the present level of the soil. Trial shafts and trenches have shown that there exist at least 6 strata of buildings one above the other, the lowest being now 30 feet below the level of the surrounding plain. Sir John Marshall gives as a probable date for the upper three cities, which are those so far most fully explored, 3300 to 2700 B.C.

Harappa is in the Montgomery District of the Punjab in a region that before modern irrigation schemes altered the character of the country was practically desert. Some of the remains found here are even older than those at Mohenjo-daro.

An exhibition of articles recovered from these excavations was recently given in Simla by the Archæological Department from which the above very brief description has been taken. More complete accounts will be found in the Annual Reports of the Archæological Survey of India.

Pre-Mauryan and Mauryan.—Between the remains of the Chalcolithic age and the earliest known relics of the historic period is a gap of 2,000 years. Of such relics the earliest are those of the time of the Mauryan Empire or somewhat previous to this (say 500 B.C. to 100 A.D.). Among evidences of this period are the *pillars* and *rock inscriptions* of Asoka. Of the pillars (monolithic columns) there are nearly 30 known of which 10 carry inscriptions. One of the most perfect is that found at Sarnath near Benares. Another is in the Fort at Allahabad and still another, brought from Topra on the bank of the Jumna, is

PLATE A.



TOWER OF VICTORY.

now seen as a prominent landmark in the Feroz Shah Kotila at Delhi. This has inscriptions of several periods but the original one in Pali is an edict of Asoka.

The capital of the Mauryan Empire was Pataliputra, near modern Patna, where recent excavation by the Archæological Department has revealed a portion of the famous wooden palisade city wall. Megasthenes, the Greek Ambassador from Seleucus to Chandragupta's court (about 300 B.C.) described the city as 9 miles long and one and a half miles in breadth protected by a massive timber palisade pierced by 64 gates and crowned by 570 towers. A portion of this wall has now been opened up for a total distance of 700 feet by the Department. It is 14½ feet in breadth and hollow inside, its inner and outer walls being constructed of heavy upright timbers spaced at intervals about equal to their breadth. The passage was roofed over with heavy beams laid across the top.

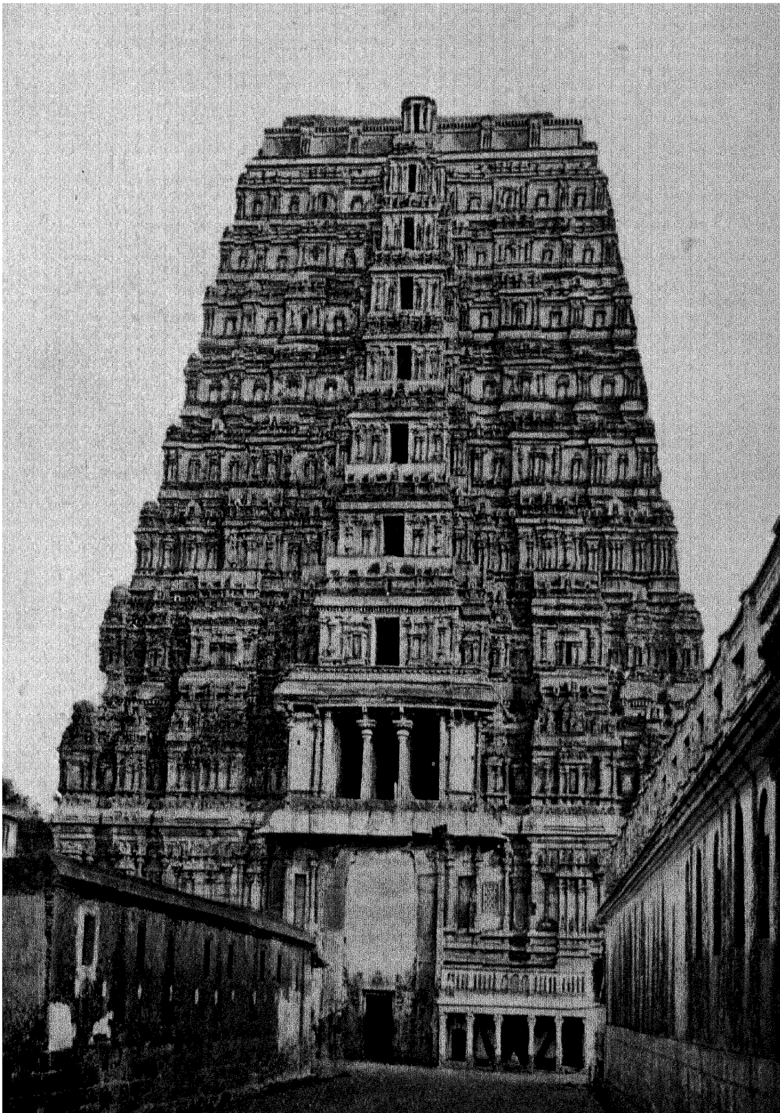
At Bhita, 11 miles from Allahabad, excavations by the Archæological Department have revealed the existence of a prehistoric site which was a fortified city from Mauryan times to the Gupta epoch. The city is surrounded by an earthen rampart surmounted by a brick wall 11 feet in thickness with bastions and guard houses. Nearly all the interior of the fort which has so far been excavated is divided up into well defined blocks by roads and narrow alleys. The most modern of the buildings are of the Gupta period and are characterised by the smallness of their rooms and the poorness of their construction. Below these were structures of the early Gupta or Kushan period constructed from materials from earlier buildings. These latter are of Mauryan age. Anterior to these (700—800 B.C.) are well made floors of concrete and burnt clay. The houses of the Maurya and Kushan period are large structures having on an average 12 rooms on the ground floor arranged round a courtyard. The upper stories were probably of wood and roofs were protected by terra cotta tiles. They resemble the dwellings of the Buddhist monasteries which were presumably copied from the domestic houses of the period. In the streets are shops with a raised platform as seen in bazaars in India at the present day.

Coins from the north and from Andhra and other kingdoms have been recovered as also terra cotta statues, figurines, etc., copper and earthenware vessels and goldsmiths' utensils, toilet boxes of steatite and marble and personal ornaments. With these are celts and stone implements of neolithic culture type, evidences of the occupation of the site by surrounding jungle tribes after destruction of the city.

Characteristic of the Mauryan period are the early Buddhist remains. Buddha lived in the reign of Bimbusara of the Sisanuga dynasty, his death being given as 487 B.C. In Maurya times Asoka greatly helped to extend and established the religion. The buildings, etc., referable to this period are Topes, Stupas, Buddhist Monasteries, etc. One of the most perfect is the great tope of Sanchi near Bhopal which members will have an opportunity of seeing. Such buildings usually consist of the central stupa surrounded by massive stone railings with gates which are elaborately sculptured. The date of the stupa at Sanchi is that of Asoka but the railings and gateways have been shown by recent explorations to date 150 to 200 years later. The monuments at Sanchi constitute the largest and most important of several groups of Buddhist monuments situated in the neighbourhood of the ancient city of Vidisa (near the modern Bhilsa) and are often referred to as the " Bhilsa Topes." From the Buddhist stupas at Bharhut (between Allahabad and Jubbulpore many sculptures may be seen in the Indian Museum, Calcutta, Bharhut Gallery). Sarnath, 4 miles from Benares, is where Buddha preached; there is a stupa of later date and many archæological features of interest including a museum for display of smaller relics found. The temple of Buddha Gaya, 7 miles south of Gaya, is another famous early Buddhist structure.

The earlier of the Cave Temples so characteristic of western India belong to this period, e.g., the cave temples of Barabar, 16 miles from Gaya which are among the earliest known examples having been excavated by Asoka and his grand-son Dasaratha, the caves of Karli, Bhaja and Bedsa near Malavli on the Bombay-Poona line (100—200 B.C.), certain of the caves at Nasik (23 caves, 100 B.C.—100 A.D.) and No. 9 cave at Ajanta.

PLATE B.



TEMPLE AT MADURA.

Associated with these temples (chaityas) were usually viharas or monastery quarters.

Taxila.—On the north-west frontier are remains known as Gandharan, ruined monasteries and buried stupas, etc., yielding sculptures having a strong Greek influence. Many of these belong to the Kushan period (Kanishka, about 125 A.D.) or earlier. The buried cities of Taxila (1st century B.C.) in particular have recently yielded much valuable material to exploration by the Archæological Department under Sir John Marshall. The remains of Taxila occupy an area of some 25 sq. miles and include 3 cities, one forming the Bhir mound, the most ancient, one known as Sirkap, a Scytho-Parthian city, and a third called Sirsukh (2nd century) probably founded by Kanishka.

Besides the buildings and streets of these extensive buried cities there are in the same neighbourhood many structures of archæological interest including Buddhist stupas, etc., of various ages, such as the Dharmarajika stupa (1st century B.C.), Kunala stupa (1st century A.D.), Mohra Maradu stupa (2nd century A.D.).

Peshawar was the capital of Gandhara and of the Kushan empire and at Peshawar is the largest stupa in India (mound of Shahjikidheri). This period represents the rise of the Mahayana (greater vehicle) form of Buddhism.

Gupta and Mediæval Periods.—Buddhist stupas, monasteries and other remains including bas-relief sculptures have been obtained at Amravati (Amravati stupa and bas-reliefs) on the south bank of the Kistna River near Bezwada (former capital of Andhra). The remains have for the most part been removed to the British and Madras Museums. More recent finds have been made on an extensive scale at Gummadidurru (Kistna District) and at Nagarjunikonda (Guntur District), the former being of the Amaravati school of sculpture which from an artistic point of view is the most attractive of all the early Indian schools.

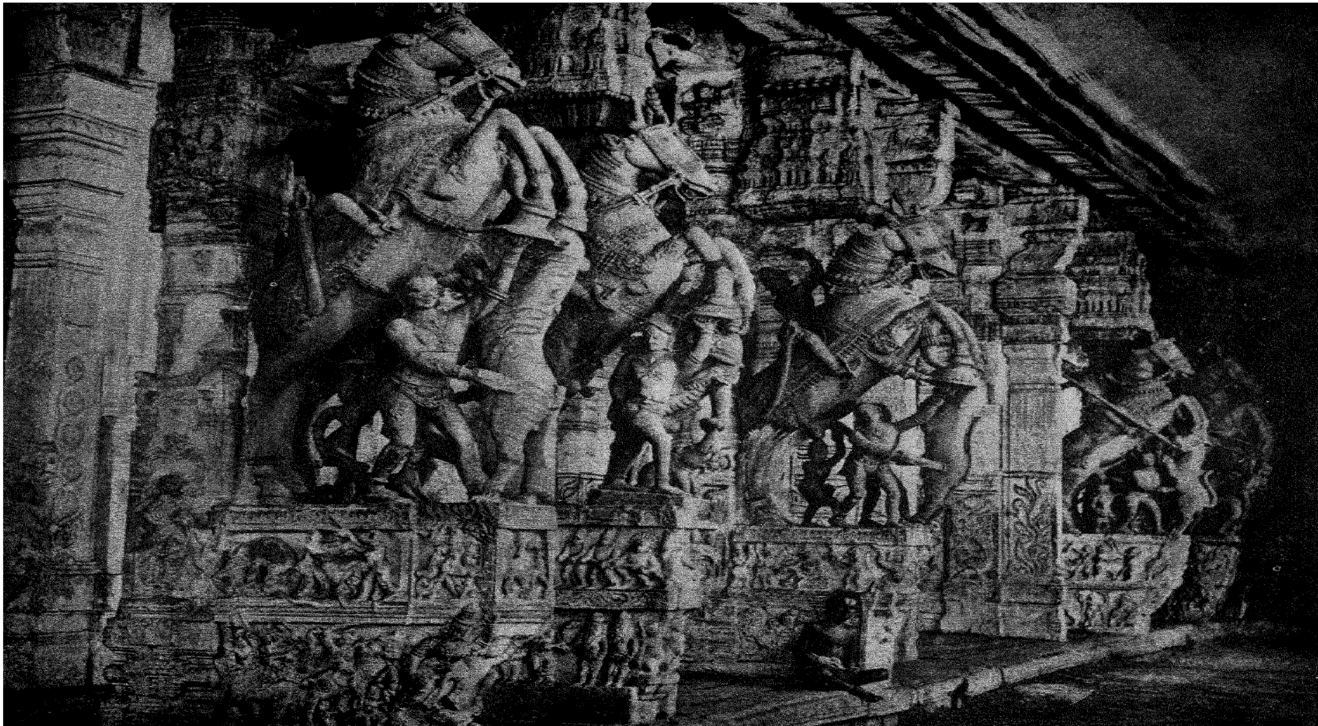
Of a later period are imposing monuments recently excavated by the Archæological Department at Nalanda and Paharpur.

Nalanda (Bihar) was a Buddhist University which flourished from the 7th to the 11th century. The finding of copper and bronze images of the 8th or 9th century with several figures of Hindu deities shows to what extent Brahmanism had then encroached upon the preserves of Buddhism. At Paharpur (Rajshahi) is a temple of immense size with Brahmanical and Buddhistic sculptures.

From about the 3rd to the 13th century belong many of the remarkable cave temples of the western parts of India. At Kanheri in Salsette near Bombay are 109 caves (200—800 A.D.). At Ellora near Daulatabad are 12 Buddhist (350—750 A.D.), 17 Brahmanical (600—700 A.D.), and 5 Jain (700—1200 A.D.) cave temples. These caves at Ellora are perhaps the most remarkable of all the cave temples including the marvellous Kailasa Temple, a complete temple 164 feet long, 109 feet broad and 96 feet high standing in a court 276 feet long, 154 feet broad and at some parts 100 feet high carved out of the living rock. The caves of Ajanta, near Jalgaon and Bhusawal, are 29 in number dating from the time of Asoka to about 600 A.D. They are famous for their remarkable paintings which are almost if not quite unique and of the greatest variety of subjects as well as being of great artistic power. These paintings, now famous, remained hidden in the Deccan jungles for nearly twelve hundred years before they were discovered in 1816. Many other caves of less importance occur in the west and elsewhere in India, among which may be mentioned the comparatively late period Cave Temples of Elephanta near Bombay.

Of later mediæval period are the various temples in the northern (Indo-Aryan) and southern or Dravidian style. Of the former type are the Durga Temple at Aiholi, Bijapur, the Great Temple and Kadaresvara Temple and several hundreds of other temples at Bhubaneswar in Orissa (600—1200 A.D.), 30 temples at Khajraha between Jhansi and Allahabad built by the Chandel dynasty (Rajput) (900—1200 A.D.) of Jain and Hindu type, and the Dilwarra temples at Mount Abu with what is said to be the most beautiful stone carving in India (100—1200 A.D.). Other examples are seen at Nagda near Udaipur and at Girnar and

PLATE C.



TEMPLE NEAR TRICHYNOPOLY

Satrunjaya in Gujarat.. Characteristic of the Indo-Aryan style is the curvilinear steeple divided by vertical bands rising above the square sanctuary.

In the Dravidian style are the remarkable Seven Pagodas (Mamallapuram) on the sea coast south of Madras City. These temples or *rathas* five in number are carved not as caves but as monolithic buildings and are unique. They date from the 7th century and were executed by Pallava kings. The Pallava Kailasanatha and Vaikuntha Perumal Temples at Conjeeveram and the Virupaksha temple at Pattadakal near Badami in the Dharwar area of Bombay Presidency (7th—8th century) are of this type. Of later date is the Great Temple at Tanjore (11th century) built by the Cholas and still later, merging into the modern and dating from the 17th century or later, are the Srirangam Temple at Trichinopoly, the Great Temple at Madura, etc. These Dravidian Hindu temples are remarkable for their extraordinary wealth of sculptured detail which gives them a character all their own. They are built with a central shrine surrounded by walls, one outside the other with the gateways increasing in size as the outer walls are reached. It is these gateways (*Gopurams*) which are often the chief feature of these temples as they appear from a distance. They rank in magnitude with any structures in the world not excepting possibly those of Egypt.

Besides the above are temples in the Deccan type (Chalukyan) instanced by the temples at Hallabid, Belur, Somnathpur, Nuggehalli, etc., in Mysore, Ittaji, Nilanga, Buchanapalli, Warangal, etc., in Hyderabad and at Dambal, Rattihalli, Tiliwalli and Hangal in the Bombay Presidency.

Rajput Palaces and Forts.—In north-western India (Rajputana) a feature of great interest are the truly mediæval forts and palaces of the various Rajput strongholds. Many of these will be seen passing in the train from Agra to Bombay, in particular the huge Gwalior Fort on its precipitous hill close to which the railway line passes (Gwalior station). Warlike and independent, the Rajput chiefs during rivalries and wars among

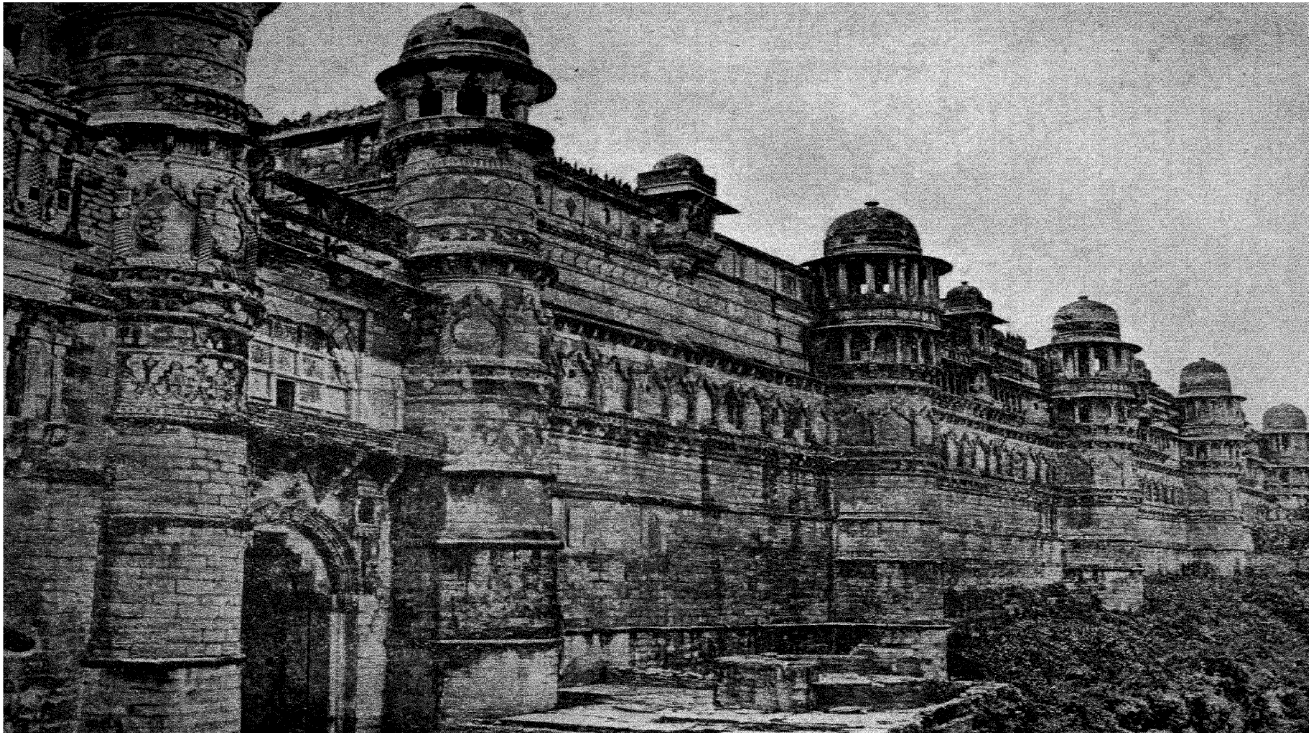
the Mohammedan kingdoms were able, during the 14th and 15th century, to obtain breathing space and later to become powerful. Famous in the critical times were the Tomars of Gwalior under the famous Man Singh (1486—1518). The great buildings of Chitor and Gwalior date from these times. Of these strongholds with their palaces, often of great charm and set in wonderful surroundings, may be mentioned the Palaces of Udaipur and Amber (1600), Alwar and Deeg of somewhat later date, and Orcha and Datia near Jhansi (17th century).

Indo-Mohammedan Period.—The Forts, Palaces, Mosques, Tombs and other archæological remains of Mohammedan origin are chiefly to be seen in northern India and since Delhi was the capital of both the Pathan and Moghul empires most of what is characteristic of this period is to be seen at this city or in its neighbourhood. Nevertheless outlying provinces and kingdoms often had special features such as are seen at Jaunpur, between Benares and Allahabad, the capital of the Sharki dynasty (1394—1476), at Malda in Bengal near which were the old Mohammedan capitals of Pandua and Jannatabad, and in the Deccan and south where the kingdom of the Bahmanis (1374—1482) broke up into the independent kingdoms of Ahmedabad, Gulbarga, Bijapur, Golconda, etc.

Among Mohammedan structures the most famous are perhaps the marble and sandstone palaces in the Forts at Delhi and Agra from representations of the interior of which, with their beautiful inlaid marble work and carved marble screens, many have directly or indirectly derived their ideas of what an eastern harem de luxe is like. Even more famous is the beautiful Taj Mahal. These date from the time of the great Moghul emperors. A description of the numerous and interesting as well as beautiful remains of this period is impossible in the space here available but the following gives a brief chronological note of the buildings, cities, etc., in the north under the Delhi Kings (so-called Pathan period) and the Moghuls.

A relic of the invasions of the Ghazni period (999—1186) is to be seen in the so-called representatives of the "Gates of

PLATE D.



GWALIOR FORT.

Somnath" carried off by Mahmud in his raid on the great temple of Somnath in Gujerat. These were brought to Agra under British rule. Of the Ghori dynasty Mu'izz-ud-din Ghori after conquering north India left as Satrap his slave Qutb-ud-din, who later became the first of the so-called Slave Kings. Qutb-ud-din (1206—10) started the remarkable Qutb Minar seen to the south of Delhi and the Quwwat-ul-Islam Mosque near this (Old Delhi, or the Qutb). Ala-ud-din of the next or Khalji dynasty of the Delhi kings built Siri, one of the Delhi cities of which little is left (1303). Tughlaqabad was built by the first emperor of the 3rd or Tuchlaq dynasty (1321). Feroz Shah's Kotila, one of the most interesting of the old Delhi cities just outside the Delhi Gate of the modern city, and with a pillar of Asoka built into one of its structures as a conspicuous landmark, was built by another of the Tuchlaq line (1354). The Kalan Musjid or Black Mosque inside the present city also dates from this period. Most of these show a very massive type of architecture.

Of the Moghul period there are, of Babar's time (1526—30) two mosques at Panipat near Delhi and at Sambhal. Somewhat later (Akbar, 1556—1605) are Humayun's Tomb at Delhi, the city of Fatehpur-Sikri, the Fort at Allahabad, the Palace at Lahore and the Red Palace at Agra. There follows (Jehangir, 1605—27) the Tomb of Akbar at Sikandra, the Tomb of Anarkali at Lahore and the I'tumad-ul-Daula Mosque at Agra. By Shahjehan (1627—1658) was built the great Jamma Musjid and the Fort and Palace at Delhi, the inner Fort and Palace at Agra, with the Moti Musjid or Pearl Mosque, and the Taj Mahal. Of Auranzeb's time there is a mosque at Lahore, a small mosque at Benares and the Tomb at Aurangabad.

Among the most pleasing relics of the Moghuls are their beautiful walled gardens, those of Shalimar and of Shahdara at Lahore being perhaps best known.

Preservation of Archæological Sites.—A word may be said on this subject. Twenty years ago the ruins round Delhi would have been found uncared for and lying in a waste of dust and broken stones. They are now seen in a setting of beautiful

sward and with gardens that are themselves a restful pleasure. Much too that was buried has been laid bare. Elsewhere in India too preservation of these irreplaceable monuments of ancient times is carefully carried out. It is to Lord Curzon in the first place that this is due and the fostering care of the Archæological Department.

XII.

RACIAL ETHNOLOGY.

BY

MAJOR R. B. S. SEWELL, I.M.S., F.L.S., F.Z.S.,

Director, Zoological Survey of India.

IT is well known that India is one of the most thickly-populated countries in the world and that within the borders of this comparatively small area is packed about one-fifth of the total population of the world. Among this mass of humanity it is not surprising that there should be a profusion of races, having different origins and speaking different languages, and to this welter of humanity all the great races of the world have contributed.

Circumstances affecting Racial History.—In attempting to reconstruct the early history of this area, one is handicapped by the fact that up till now no remains of Palæolithic man have been discovered, and one must, therefore, rely for evidence, on which to base one's conclusions, on the characters and distribution of the various tribes and races that are in existence at the present time. Wave after wave of humanity has flocked and is still flocking into this country and in many instances the earlier inhabitants have been pushed slowly but surely out of the more fertile areas into remote and often inaccessible and inhospitable regions, where at the present day small tribes still linger as evidence of and survivors from an originally widely-spread and possibly far more prosperous community. Oceanic islands and deep forests have ever been

the final refuge of these dispossessed races and around the shores of India or in her dense forests there are, still surviving, numerous small scattered tribes such as the Andamanese and Nicobarese of the Bay Islands, the Salons, or as they call themselves the "Mawken" of the Mergui Archipelago on the coast of Southern Burma, or the Veddas of Ceylon; while in the dense forests of the Central Provinces and of Southern India are other primitive tribes such as the Gonds of the Central Provinces, the Bhils of Rajputana and Kathiawar, the Todas of the Nilgiri Hills and the Santals of Orissa and Chota Nagpur. Each of these tribes provides us with evidence of the past and where the expulsion of the early communities was not complete, the caste system has stepped in to perpetuate the evidence of their former existence and among the lowest castes there still survive the descendants of the original inhabitants, modified to but a little extent, if at all, by interbreeding with the successful invader.

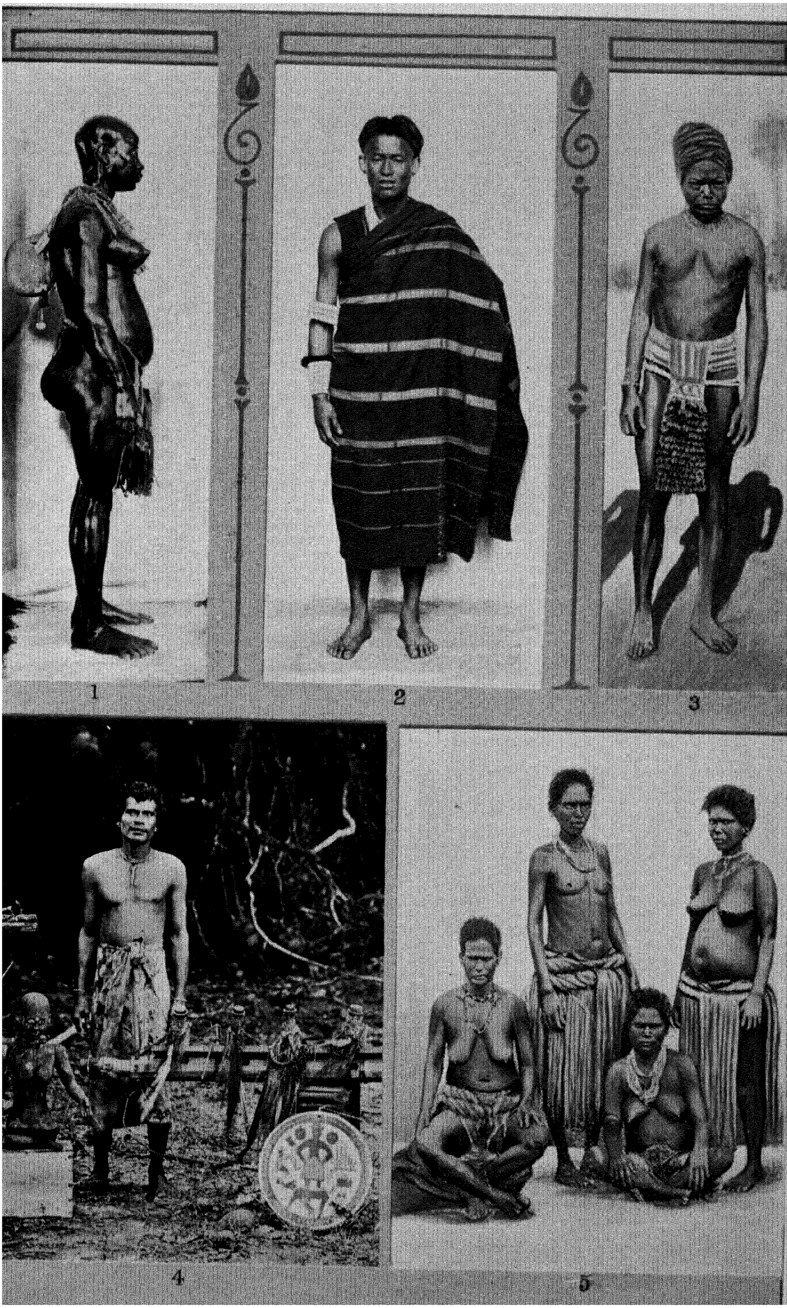
Situated as India is on the southern coast of the great Asiatic continent, with the sea on both east and west and the barrier of the Himalayan Mountains surrounding her northern frontier, the number of points of easy access are but few and it is but natural that the successive migrations of races and tribes that have moulded and fashioned India into what she is to-day, have in most instances come in through the passes on the North-West Frontier, and that at times the full flood of the mass-migration passed India by, only a lesser back-wash being flung over the protecting mountain chain into the Peninsula.

Early Civilisations.—The cradle of the human race and indeed of the whole Primate stock is, in all probability, to be found in the Central Asiatic Plateau, and in or near this centre successive races of mankind appear to have evolved and from it wave after wave has flooded outwards in all directions. The earliest records of any civilisation in this country are the remains that are now being excavated at

EXPLANATION OF PLATE I.

1. An Andamanese woman wearing her late husband's skull.
2. A Naga from Assam.
3. A Savara man of the Ganjam Hills (from Thurston).
4. A Nicobarese man with his scare devils.
5. Thanda Pulaya women of Cochin (from Aiyer).

PLATE I.



Mohenjo-daro and Harappa along the Indus Valley and those found at Aditanallur in the Madras Presidency; the date of the former is estimated to be about 3000 B.C. and of the latter a little later. In these remains we have evidence of a high state of civilisation and culture comparable to the civilisations of Egypt and Babylonia, but a study of the physical characters of these early peoples and a comparison with the primitive tribes indicates clearly that the founders of this culture were by no means the earliest inhabitants of this country and probably at least two races of mankind had preceded them; but for the evidence of the existence of these earlier races we have to go not to the remains of their culture but to the actual descendants that are still living in India today. In the following account of the early history of this country I have adopted the system of classification put forward by Dixon and others and based on the physical characters and not the cultural or linguistic system of classification of earlier workers.

Racial Origins.—The earliest stock with which we are acquainted and possibly the earliest to reach this country was a race the origin of which is somewhat obscure but which appears to have been a blend of two stocks, the Proto-Australoid and the Proto-Negroid. Of these two stocks the former is regarded as the descendant of Neanderthal man, the race that is so widely distributed throughout Europe in the early Palæolithic period and the ancestors of the Aborigines of Australia and Tasmania. Of the origin of the Proto-Negroid race but little is known; up to the present time this type has only been found in the Grimaldi caves of the Riviera and in a few areas in South Africa, where the remains of this or a very similar race, the Boskop, have been found; but despite our lack of knowledge regarding the origin of this blend, the evidence appears to be quite clear that the race was widespread throughout the whole of Southern Asia and that this long-headed dark-skinned Negroid type extended from India round the shores of Asia to Kamchatka.

Pre-Dravidian and Dravidian Races.—Gradually these early inhabitants of India became split up and the main body was pushed southwards, though other descendants are to be found in scattered tribes throughout the Indian Peninsula. All these descendants are characterised by the possession of a long head, with a low vault, a broad or moderately broad flat nose, dark skin and short stature, the hair varying from wavy to curly but never actually woolly-like that of the true Negro. Among these descendants two subdivisions can be detected; in the one the nose is markedly broad and this class constitutes the wilder and less civilised tribes such as the Savaras of Ganjam, the Thanda Pulayas of Cochin, the Shillagas and Irulas of the South, the Gonds of the Central Provinces, the Bhils of Rajputana and Kathiawar and the aboriginal tribes of Chota Nagpur including the Santals that are found also in Orissa, tribes that have been grouped together under the term "Pre-Dravidians"; in the second group, which embraces the Tamils of South India and the Veddas of Ceylon, the nose is less broad and the term "Dravidian" has been applied to them but, apart from the somewhat less breadth of the nose and the fact that these people are at the present day rather more civilised or perhaps it would be more correct to say less degraded than the others, there is no evidence that they belong to a different race. It was the descendants of this latter group that left the traces of their comparatively high state of civilisation in the remains that have been excavated at Aditanallur in the Madras Presidency.

Palæ-Alpine Race.—By the time that this first race had established itself throughout India a new type had arisen, probably in or near the same original home of the human family in Central Asia; the various offshoots of the first stock had been characterised by the possession of a long or dolichocephalic skull but this new race was a broad-headed one, of a yellow coloured skin and with straight black hair. This stock exhibited two main divisions, known respectively as

the Palæ-Alpine, in which the nose was broad, and the Alpine, in which it was narrow. The wave of migration of this double stock travelled in two directions; one went eastwards and spread across Asia and past the Behring Straits into America and the second travelled westwards into Europe, "blazing the trail which was followed some thousands of years later by the Tartar-Mongol hordes" (Dixon). Probably about the time of this westward migration an offshoot turned southward and spread through Arabia and then turned east and penetrated into India, and this wave has left its traces all along the Western and North-Western Himalayas, where they can still be detected in the so-called Pathan tribes of Achakzai, Tarin and Kakar, as well as in the Brahuis of Baluchistan. The pressure of this invasion forced the original occupants to migrate and the main mass of the Proto-Australoid-Proto-Negroid stock moved to the south into Southern India and across the Pamban Pass and Adam's Bridge into Ceylon; but a part of the older race migrated eastward and to-day all along the Ganges Valley and still further east we find the descendants of the broad-nosed or "Pre-Dravidian" part of the race and especially so in the lowest castes, the lower the caste the larger being the proportion, and as examples we may cite the Chamar and Koiri, the aborigines of Chota Nagpur and the neighbouring parts of Bengal, the Mundas, Korwa, Malé, Mal Pahari, etc. Along the west coast of India the invader and invaded appear to have mixed and interbred, for the Mahrattas, Gujratis and the Coorgs of Western India show affinities to both the Alpine and the Proto-Australoid-Proto-Negroid stocks.

Mediterranean Race.—Still later a third great wave of humanity appears to have flooded into India from the same quarter, namely, the north-west. This new race, the physical characters of which are the possession of a long head, usually extremely long, a narrow nose and a brown skin, established itself in Western Asia and around the shores of the Mediterranean Sea and built up a high state of civilisation

in Egypt and later pushed northwards into Europe, but a branch of this stock migrated eastward through Arabia and Turkestan, probably as far as Western China. This Mediterranean race, as it is called, can be traced through Sumeria in Mesopotamia and into the Indus Valley and in both areas their remains are associated with those of a few individuals of the previous Alpine or Palæ-Alpine broad-headed stock, so that it is at present doubtful whether the culture and civilisation of Mohenjo-daro Harappa, the oldest of which we have any record in India, were built up by the earlier inhabitants or by the newcomers. Be this as it may, the Mediterranean race spread into India and gave rise to the Hindus and it is probable that this invading stock was not quite a pure one but was mixed with a certain amount of the Caspian or Nordic stock, that in the main populated Russia and Northern Europe at about this time.

Displacement of Palæ-Alpine Stock.—The descendants of this Mediterranean race are at the present day predominant in the North-West Frontier districts and in the Punjab and the greater part of Rajputana, where they have given rise to the Sikhs, the Rajputs and to some of the Pathans. The penetration of the Mediterranean race was accompanied, though to a somewhat less extent than usual, by a pressure that forced the Palæ-Alpine stock to migrate eastwards and some offshoots of this displaced race even penetrated as far east as Assam and Burma, where to-day we find their descendants surviving as a series of scattered tribes, more or less modified by interbreeding with the earlier inhabitants of the Proto-Negroid stock; along the Brahmaputra Valley we now get a series of tribes all of which show this character in common, viz., the possession of a long head and a broad nose; such tribes include the Abors, the Miris, Dafflas, Garos, Kukis, Manipuris and some of the Nagas, and in all these the Palæ-Alpine character is well-marked; and in a more or less broken area in the same general quarter we find other tribes such as the inhabitants of Tipperah, the Mikir, the Ao Nagas,

the Sema Nagas and the Ahoms, in which the Palæ-Alpine characters are equally well-marked but which show also a clear trace of the older Proto-Negroid stock.

The Moghal Invaders.—At about this period in Indian history the general character of these immigrations begins to show a change. Whereas formerly the original inhabitants were for the most part driven bodily out of the invaded area, we now find the invaders settling down in the country and establishing themselves as a local aristocracy, the previous inhabitants being compelled to carry out the menial tasks, and in consequence of this, the invaders produced a much less radical change in the character of the population.

The next great invasion came again from the north-west, and this time it appears to have been a second invasion by the Palæ-Alpine and Alpine broad-headed races. The main mass-movement of this migration seems to have had its origin somewhere in Mongolia and to have moved from east to west. From its centre it passed westwards through Russia and on into Europe, but a branch turned southward and then east again and finally penetrated into India and established the Great Moghal Empires. It is probable that this invasion set up a certain degree of internal movement in the existing population, though, as I have already mentioned, this feature was becoming less marked, and it may be that it was at this time that the Todas, the Nambudri Brahmins and the Nayars of Southern India, all of whom are long-headed and are related, anthropologically, to the people of North-Western India, migrated to their present homes.

Further India.—The history of Further India appears to have been somewhat different from that of the Peninsular region. Here the earliest inhabitants appear to have been the Negrito Pigmy stock, a race that is characterised, as the name implies, by very short stature combined with a broad head, jet black skin, and frizzy hair; but at a very early period in history this stock had become split up and

driven to the south and east. One branch of the race succeeded in crossing the sea and took refuge in the Andaman Islands where they still survive as the little tribe of the Andamanese. These Negritos appear to have been displaced by a race that was characterised by the possession of a short stature, brown skin, a long head, a nose that was flattened and wavy black hair. This later race appears to have been somewhat akin to the "Dravidian" branch of the Proto-Australoid-Proto-Negroid race that we found in South India, but whether or not they are identical it is impossible to say: the term "Nesiot" has been given to this race by Haddon and Buxton, and it is this race that has given rise to many of the tribes in and around Malaya and the islands to the east. The "Nesiots" forced the Negrito Pigmies to move to the remote islands around the shores of South-Eastern Asia, where we still find traces of them in the Philippine Islands and New Guinea, and themselves occupied the region of Burma and the Malay Peninsula. At a very early date, however, a new invasion of this region took place and a branch of the Palæ-Alpine stock made its way southwards from the Central Asiatic Plateau and established itself in a settlement around the upper reaches of the Irrawaddy River. This branch of the Palæ-Alpines corresponds to the stock that Haddon has called the "Pareoean" race and exhibits a short stature, broad head, short flattened nose and the Mongolian eye with straight black hair. At some subsequent date, probably about the commencement of the Christian era a further movement started and a branch of this Palæ-Alpine stock migrated westwards and established a subsidiary race in the Chindwin and Kaladan Valleys in Northern Arakan; the line of migration of the main stock, however, was southwards along the Irrawaddy River, where they established the kingdom of Burma. It was in all probability this southward movement that forced the earlier "Nesiot" inhabitants to migrate and while the bulk of them moved to the Malay Peninsula, a branch took to the islands of the Mergui Archipelago and are found living there to-day,

where they are known as the "Mawken" or Salons, a small tribe of boat-dwellers. Whether this mass-movement was also responsible for the migration of the present inhabitants of the Nicobar Islands we cannot say; all that appears to be fairly certain about this latter tribe is that they are related to the Malays and that similar types can be traced in the islands around the Malay Archipelago and as far east as Formosa. At a somewhat later date, about 600 A.D. a further invasion of the Palæ-Alpines swept over Indo-China and partly penetrated into Burma, where they still remain as the various tribes of the Shan States.

Modern Race Movements.—With increasing facilities for transport as a result of progressive civilisation and culture, invasions into India became more frequent and of a somewhat different type. A succession of inroads took place across the North-Western Frontier, most of which, as for example, that of Alexander and his forces, were of the nature of a military invasion and the subsequent occupation of the country was but transitory and left little, if any, permanent effect on the population; similarly the migration of the Parsees from Persia to Bombay resulted only in the addition of yet another racial type to the already extremely complicated population of this country without affecting the earlier inhabitants.

The last of the great immigrations into India came by sea and not by land. With the development of shipping in the fifteenth and sixteenth centuries and the discovery by the peoples of the west of the wealth of India, a steady stream of immigrants of the Caspian-Mediterranean races from Europe commenced to arrive. The Dutch, Portuguese, French and British all established trading centres and colonies and, after varying fortunes, India eventually became a part of the British Empire. As in the previous invasion by the Caspian-Mediterranean race, these later invaders made no attempt to drive out the earlier inhabitants but once

again established themselves as an Aristocracy. Many of them settled in the country and in numerous cases interbred.

Within the last few years a new peaceful penetration has started and is still going on along the North-Eastern Frontier, where India abuts on China. Though the movement appears to be still in its infancy, the Chinese are steadily, but none the less surely, penetrating into Burma and by inter-marriage with the Burmese are establishing a new race of half-caste Chino-Burmese, the counter-part of the Eurasian or as he is called to-day the Anglo-Indian. Colonies of pure or half-caste Chinese are springing up in the larger towns of India and especially in and around the towns and villages of Burma, and even as far afield as the Nicobar Islands this Mongol race is establishing itself and is rapidly causing the disappearance of the original stock, drink and disease being the two chief factors in this regrettable occurrence.

XIII.

ZOOLOGY OF INDIA.

BY

B. PRASHAD, D.SC., F.E.S.,

Zoological Survey of India.

PROBABLY no country on the face of the earth has a richer or more varied fauna than India, and the study of the problems connected with the origin and relationships of the different elements in this fauna has attracted naturalists from very early times. The lakes, the river systems with their extensive deltaic and estuarine areas and the backwaters of India offer the most favourable conditions for the study of the origin of the freshwater and land animals from marine forms, while the seas and oceans along the coasts and the extensive coral reefs have as rich a marine fauna as any other region. The rapids in the higher reaches of the rivers further offer extraordinary examples in the adaptation of different classes of animals to their peculiar habitat. It is, therefore, impossible to give in the limited space allowed by the Editor of this volume a conspectus of Indian Zoology, which will be at once brief and illuminating, and shall contain information about all the various aspects of Indian Zoology. In the present note I have limited myself to an account of the physiography of the area in relation to the fauna, the relationships and origin of the fauna and have added a few notes on some of the outstanding forms in the various groups of the Animal Kingdom.

Territories comprised.—The limits for this area were admirably described by Blanford as consisting "of the

dependencies of India with the addition of Ceylon, which, although British, is not under the Indian Government. Within the limits thus defined are comprised all India proper and the Himalayas, the Punjab, Sind, Baluchistan, all the Kashmir territories with Gilgit, Ladak, etc., Nepal, Sikkim, Bhutan, and other Cis-Himalayan States, Assam, the countries between Assam and Burma, such as the Garo, Khasi and Naga Hills and Manipur, the whole of Burma, with Karenni, and of course Tennasserim and the Mergui Archipelago, and lastly the Andaman and Nicobar Islands;" with this we have also to include the Laccadive and Maldive Islands. The area of India is very large, roughly, 1,800,000 square miles, and it will be presumptuous to claim that we are, by any means, fully acquainted with all the forms of animal life which inhabit this vast region, still one would not be far wrong in saying that we are fairly well informed about the main features, and in many cases, even the details of this fauna.

Zoogeographical Regions represented.—The limits of India, as defined above, fall mainly within the Oriental (Wallace), or the Indo-Malay (Elwes) region. There are, however, some inconsistencies in this classification, and as Blanford rightly pointed out, parts of the Indo-Gangetic Plain, as also the Himalayan subregion, are related more to the Holarctic or the Palæarctic than to the Indo-Malayan or the Oriental Region. Blanford's conclusions were based mainly on the distribution of the Vertebrates, but the distribution of the Invertebrates, so far as they are known, fully confirms these conclusions.

With our present knowledge of the fauna of India, the area may be divided into five subregions. This division is based on the relationships of the various groups of the Animal Kingdom, both Vertebrates and Invertebrates, and corresponds broadly to the Physiographical divisions of the area.

Subregions.—1. Western Frontier Territory including Baluchistan, the North Western Frontier Province and the

greater part of the Punjab. 2. The Himalayas consisting of the Upper Indus Valley with Ladak, Gilgit etc., the Western Himalayas from Hazara to the western limit of Nepal, and the Eastern Himalayas from the limit of the Western Himalayas to the Mishmi Hills above the Assam Valley. 3. Assam and Burma comprising the greater part of the Lower Brahmaputra Drainage System and the Burmese territory including Tennasserim. 4. The Gangetic Plain to the east of Delhi, and including the whole of the United Provinces, Bengal and parts of Assam up to the base of the Assam Hills, together with the plain of the Brahmaputra as far as Goalpara and including Cachar, Sylhet and the plains of Tipperah. 5. Peninsular India, with the Malabar zone as a very distinct subdivision, and Ceylon.

The fauna of the Western Frontier Territory differs greatly from that of the rest of the area, and is not truly Indian. Practically all the genera of the Vertebrates met with in this area are either truly Holarctic or Palæarctic, or are peculiar to the area; the relationships of the latter are also with the Palæarctic rather than with the Indo-Malayan forms. Blanford from the distribution of the Vertebrates suggested that this part of the Indian Territory should be excluded from the Indo-Malayan Region, and classified with the Eremian or Mediterranean subregion of the Palæarctic. This view has received full support from the distribution of the various groups of the Invertebrates which have been investigated since. Some forms of the Gangetic Plain are also to be found in this area, but they have only migrated from the adjacent region, and are of no value from the zoogeographic point of view. The area consists of desert or semi-desert regions, except near the rivers or the artificially irrigated parts. The annual rainfall is not very heavy and the fauna on the whole is poor.

In the Himalayas the higher ranges above the forest limits, a part of the Tibetan plateau and the Upper Indus

Valley including Ladak, Gilgit, etc, form a separate subregion. This area is very bare, the mountains are perpetually covered with snows and there is a great deal of difference between the elevation of the mountain ranges and the valleys in between; the annual rainfall is generally low. The region so deliminated has an almost truly Palæarctic fauna, and its animal life shows no affinities whatsoever with the Indo-Malayan types. The forest zone of the Himalayas forms a belt of varying breadth between the higher mountain ranges on the one hand and the Indo-Gangetic Plain on the other. In this area are included the slopes of the hills from the base to an altitude between 10,000—14,000 feet, the uppermost limit of the forest zone. The rainfall is heavier, more so in the eastern than in the western parts, and the forests of the eastern ranges are more extensive, richer and truly tropical. A fair number of Tibetan or Palæarctic animals from the higher reaches of the mountains wander into the forests, while a few forms penetrate northwards into the warmer valleys from the plains in the south. The western forest region has a predominantly Palæarctic fauna, while the eastern, which has a very marked Malayan element, was for this reason separated by Blanford with Assam, Burma, Southern China, etc., into the so-called Trans-Gangetic subregion.

In Assam and Burma the northern region comprising the northern part of the drainage area of the Brahmaputra and Assam, consists of hilly tracts with dense forests except in the plains of Assam; the annual rainfall in this tract is fairly heavy. Physiographically, parts of this area belong to the Indo-Gangetic Plain, but its fauna is distinctly Burmese. In Upper Burma, which is roughly the drainage area of the Irrawadi, there is a large number of hills thickly covered by forests, while the undulating ground between the mountains is densely overgrown by brushwood and high grass; the annual rainfall in this region is pretty heavy. The Tennasserim area consists of two distinct tracts, (i) the northern, covered by thick forests on a hilly ground and with a fauna of the

Burmese type; and (ii) the southern area which in its physiography is similar to the northern, but where the annual rainfall is not so heavy as in the northern area, and the fauna of which is distinctly Malayan. The Andaman and Nicobar Islands, which are also included in this subregion, are covered by dense forests, and have a heavy rainfall. The fauna of these islands is by no means identical; the Andamans having an impoverished Burmese fauna, while that of the Nicobars is undoubtedly Malayan.

Since the main part of the Indus Plain has been separately considered above in the Western Frontier Territory, I use the name Gangetic Plain for the rest of the Indo-Gangetic watershed. Its extent has been noted already, and its physical features only need be considered. Most of the western area is cleared and used for cultivation, and only some of the uncleared areas are covered by tall grasses. The annual rainfall generally is not very heavy. In the eastern part of the area, except for the Sunderban forests in the deltaic region of the Ganges, the country is similar to that in the north-western part, but the rainfall is heavier, and there are more extensive tracts of uncleared land. The fauna of the area is generally of the same type as that of Peninsular India, but in the north-eastern parts there is a large admixture of the eastern or Trans-Gangetic types. The freshwater fauna shows a very marked similarity and in many cases actual identity with the forms occurring in the Indus System. This is to be explained by the connection of the Indus and the Ganges in the Tertiaries, when, according to the geologists, there was a single river—the large Indobrahm or the Siwalik River. This river is supposed to have run to the south of and parallel to the Himalayan Chain from Assam in the east to the north-west corner of the Punjab, and then flowing south-west opened into the Miocene Sea. The elevation of the Himalayas brought about a dismemberment of this Tertiary river into the Indus System with the Punjab rivers on the one hand, and the Gangetic System on the other. The similarity of the

fauna in these river-systems is to be traced to this Tertiary connection.

The greater part of Peninsular India, with the exception of the Malabar Tract, consists of either cultivated land or low hilly country covered with brushwood or thin forests; the average rainfall is from 35—50 inches. In the Malabar Tract, on the other hand, we have the high mountain ranges of the Western Ghauts and the west coastal area of the Peninsula. Most of this part is covered with thick tropical forests, though there are many places near the coast which are cleared and cultivated. The island of Ceylon, like Peninsular India, consists of two types of country. About three-fourths of the island along the north and the east resembles the main area of Peninsular India, and is almost plain or only slightly undulating country of no great elevation, with an average annual rainfall of about 50 inches. The rest or the south-western part of Ceylon, like the Malabar Tract, is hilly, with rich tropical forests and an average rainfall of over 100 inches.

Fauna Constituents.—In Peninsular India and Ceylon it is possible to distinguish three distinct constituents of the Fauna, and for which the terms Drawidian, Aryan and Indo-Malayan, as suggested by Blanford, may be employed. The Drawidian element consisting mainly of Batrachians and Reptiles, is best represented along the Malabar coast in the south of the Peninsula and in Ceylon, and gradually disappears in the north. It is a remnant of probably the oldest fauna of the area, which inhabited India when Peninsular India was connected across the Indian Ocean by land with Madagascar and South Africa in Mesozoic and early Cenozoic times. The Aryan element represented by Reptiles, Birds and Mammals, has distinct affinities with the Pliocene Siwalik fauna of India and with the Ethiopian and Palærctic types; it has been suggested that this element came into India about the Pliocene times. The Oriental or Indo-Malay element is similarly represented by Birds and Mammals, and like the Aryan

appears to have migrated into Peninsular India and Ceylon about the Miocene times; it has since driven the Drawidian element to the higher ranges of the hills.

In Peninsular India there are further certain genera of Mammals and Reptiles which occur also in Assam and Burma, or even in the Malay Peninsula, but are not found anywhere in the intermediate region of the Gangetic Plain. Amongst Invertebrates there are also extraordinary examples of genera occurring in Peninsular India, the nearest allies of which are found in North Africa or Tropical America. These relationships of the Indian fauna have been explained as being due to early land connections between India and Africa and earlier on with America, but opinions differ as to their exact significance and importance, and it is not possible to discuss the whole question here.

I will now include a few notes about the different groups of the Animal Kingdom as they are found in India.

Vertebrates.—The Mammalian life of India is fairly rich, and with the exception of the Monotremes and Marsupials, practically all the different orders and families of this phylum are represented. It is not necessary to mention well-known animals like the elephant, the rhinoceros, the tiger, the panther, the deer, etc., but reference may be made to the lion (*Felis leo*), which at the present day is verging on extinction in India and is only found in Kathiawar. Within recent years the African lion has been introduced into Gwalior, and may become established in India. Among specially interesting types may be mentioned the so-called wild-dog (*Cyon dukhunensis*), the Himalayan red cat-bear (*Aelurus fulgens*), the wild sheep of the Himalayas (*Ovis spp.*), the markhor (*Capra falconeri*), the flying squirrels (*Pteromys, Eupetaurus,* etc.) and a number of other forms. Amongst the aquatic mammals, the dolphin (*Platinista gangetica*), the porpoise (*Orcella brevirostris*) and the marine dugong (*Halicore dugong*) deserve to be noted.

The avifauna of India is rich in species, and according to a recent list over two thousand species and subspecies are found in the area. Though not rich in forms with a gorgeous plumage, as some other tropical regions are, India has many curious and beautiful varieties of birds. The peacock (*Pavo cristatus*) and its white mutant and many beautiful pheasants are worth a mention, and the Parrot family has numerous representatives. Amongst the birds of prey, many are trained for falconry. Game birds abound in most parts, and from amongst the water-birds a great variety of them are found in the Chilka Lake, the Manchar Lake and other jheels and marshy areas, while on dry land there are the pigeons, partridges, pheasants, quails and the red jungle fowl.

In India the crocodile tribe is represented by the river crocodile (*Crocodilus porosus*), the marsh crocodile (*C. palustris*) and the Gharial (*Gavialis gangeticus*). There are all kinds of tortoises and turtles, marine, freshwater and land, but none of them offer any exceptional points of interest. The lizards are very numerous, both in numbers and variety, and we may specially note the small house geckos (*Hemidactylus spp.*) the monitor lizards (*Varanus spp.*), the spiny-tailed lizard (*Urcmastix hardwickii*) and the flying lizards (*Draco spp.*). The Snake family is very fully represented, from the thin thread-like blind-snakes (*Typhlops spp.*) to the two species of the pythons (*Python molorus* and *P. reticulatus*). Of the poisonous snakes the most dangerous are the Cobra (*Naia tripudians*), the King Cobra (*Naia bungarus*), the common Krait (*Bungarus cæruleus*), the banded Krait (*Bungarus fasciatus*), Daboia (*Vipera russelli*) and the saw-scaled Viper (*Echis carinata*). There are in addition many other species of poisonous snakes found in the Indian limits, but none of them are, so far as is known, fatal to man.

Frogs and toads are represented by large numbers of forms of cosmopolitan genera like *Rana* and *Bufo,* and the only really interesting types among them are the peculiar

genera of toads like *Callula, Calophrynus, Cacopus, Glyphoglossus.* Only a single form of newts, *Tylototriton verrucosus,* is found in Eastern Himalayas, while limbless amphibians or Cæcilidæ are represented by genera like *Icthyophis, Urotyphlus* and *Gegenophis* in Peninsular India, Ceylon, Assam and Burma. Mention may also be made of the Cæceilian *Herpele fulleri* from Cachar; no other species of this genus is found in India and its nearest allies are found in West Africa and Tropical America.

All water areas like ponds, pools, lakes, rivers, estuaries and seas of India abound in fishes of various kinds, and it is impossible to include here even a summary notice of the different forms. From the scientific point of view, the really interesting types are the directly air-breathing fishes like the climbing perch (*Anabas scandens*), Magur (*Clarias batrachus*), Singi (*Saccobranchus fossilis*), all of which have accessory breathing organs and can live outside water. Certain genera of freshwater fishes like *Kanduka, Pseudochineus,* etc., have developed special adaptive characters in response to their habitat. The marine and estuarine ovoviviparous and viviparous sharks and rays with the peculiar structures for the feeding of their embryos during a partial or complete intrauterine period of existence, deserve a special mention, and so also the cat-fishes which protect their young by carrying them in the mouth during the earlier stages. There are also a huge variety of deep-sea fishes of fanciful forms and with peculiar light-emiting organs. The common freshwater carps of the genera *Labeo, Catla, Cirrhina* and *Barbus,* and cat-fish of various genera like *Aoria, Arius, Wallago,* etc., are chiefly used as food all over India. The most highly prized fish, however, is the Hilsa (*Hilsa ilisha*), an anadromous fish of the herring-family, which ascends freshwater rivers for spawning, and is caught in large quantities. The most interesting fish for the Anglers is the Mahseer (*Barbus tor*), various forms of which are found in the rivers all over India and which is known to reach over 110 lbs. in weight. From amongst the

sea fishes mention may be made of various genera of sea-perches, mackrels, pomfrets, mullets, flat fishes, herrings, and the Bombay Duck.

Invertebrates.—The invertebrates whether on land or in freshwaters, estuaries or the seas, are extremely abundant. It is not possible to include anything like a summary here, and I will only refer to a few forms which are of special interest. The freshwater medusa (*Limnocnida indica*) from the tributaries of river Kistna in Peninsular India with its nearest allies in Tropical and South Africa deserves a special mention. The freshwater sponges and polyzoa are fairly numerous and several of them show distinct affinities with the American and African forms. Amongst molluscs the outstanding Gastropod genera are *Camptoceras* of which a species occurs in Japan, *Camptonyx* and *Lithotis,* which are only found in India, and the Aethirid bivalve *Mulleria* represented by a single species in Mysore, other species of the *Mulleria* are found in South America. The only outstanding type amongst the Arthropods as a whole is the archaic form *Typhloperipatus williamsoni,* a peculiar form of the Onychophora, which was discovered by Dr. S. W. Kemp in the Abor country in E. Assam, and which is the only record of a form of this group within the Indian limits. The Crustacean element is very well represented by prawns, lobsters, crabs and other smaller forms, and we may note here forms like the huge marine Isopod *Bathynomus giganteus* and the robber-crab *Birgus latro.* It is not proposed to consider the insects of India in detail here, but it may be mentioned that within the Indian limits there is the home of such interesting forms as the leaf-butterflies, leaf-insects, praying mantis and several other grotesque types.

No account of the Zoology of India would be complete without a reference to the work of such institutions as the Asiatic Society of Bengal, Indian Museum, and the Zoological Survey of India, Calcutta, Madras Museum, Colombo Museum,

the Bombay Natural History Society, Bombay and several Entomological institutes like those at Pusa, Dehra Dun, Coimbatore and Poona, which have done pioneer work in getting the fauna of this huge country worked out. The voluntary and disinterested work of such authorities, to mention only a few, as Hamilton-Buchanan, Legge, Moore, Hodgson, Mclelland, Blyth, Stoliczka, Blanford, Jerdon, Hume, Day, Anderson, Wood-Mason, Alcock and Annandale, also deserves special notice.

The literature on Indian Zoology is very scattered, but an official "Fauna of British India" is issued by the Secretary of State and already 47 volumes of it dealing with various groups, have been published. Of other scientific journals dealing with the Zoology of India, "Records" and "Memoirs of the Indian Museum," "Journal and Proceedings" and "Memoirs of the Asiatic Society of Bengal," "Journal of the Bombay Natural History Society" and "Spolia Zeylanica" (Ceylon Journal of Science) may be specially referred to.

XIV.

INDIAN BOTANY.

BY

J. M. COWAN, D.SC.,

Officiating Director, Botanical Survey of India.

THE study of Indian plants dates from very ancient times. In classical Indian literature and in the writings of the great Indian poets, frequent mention is made of the beauty of plants. Thus the great poet Kalidasa, describing the red lotus flower, says that it surpasses even the beauty of the moon. Plants have been revered even from the earliest times. In the Rig Veda, the Soma plant is addressed as follows:—

> "Thou Soma, fond of praise, the Lord of plants and life to us,
> Be unto us, Soma, the bestower of wealth, the remover of disease,
> Exulting Soma! increase with all twining plants."

Plants, in India, even more than in most other countries, enter into the daily life of the people and form an indispensable part, not only of their diet but of almost every activity. One need only visit some of the tribes living in a bamboo country to realize the extraordinary adaptability and infinite uses of this plant alone. Many Indian tribes have an intimate knowledge of their local plants and their properties and the study of the etymology of plant names will often reveal much of the habits and customs of the people. Although a very considerable knowledge existed, especially of

the medicinal properties of plants, before the beginning of the nineteenth century no systematic investigation had been made nor was a methodical classification attempted.

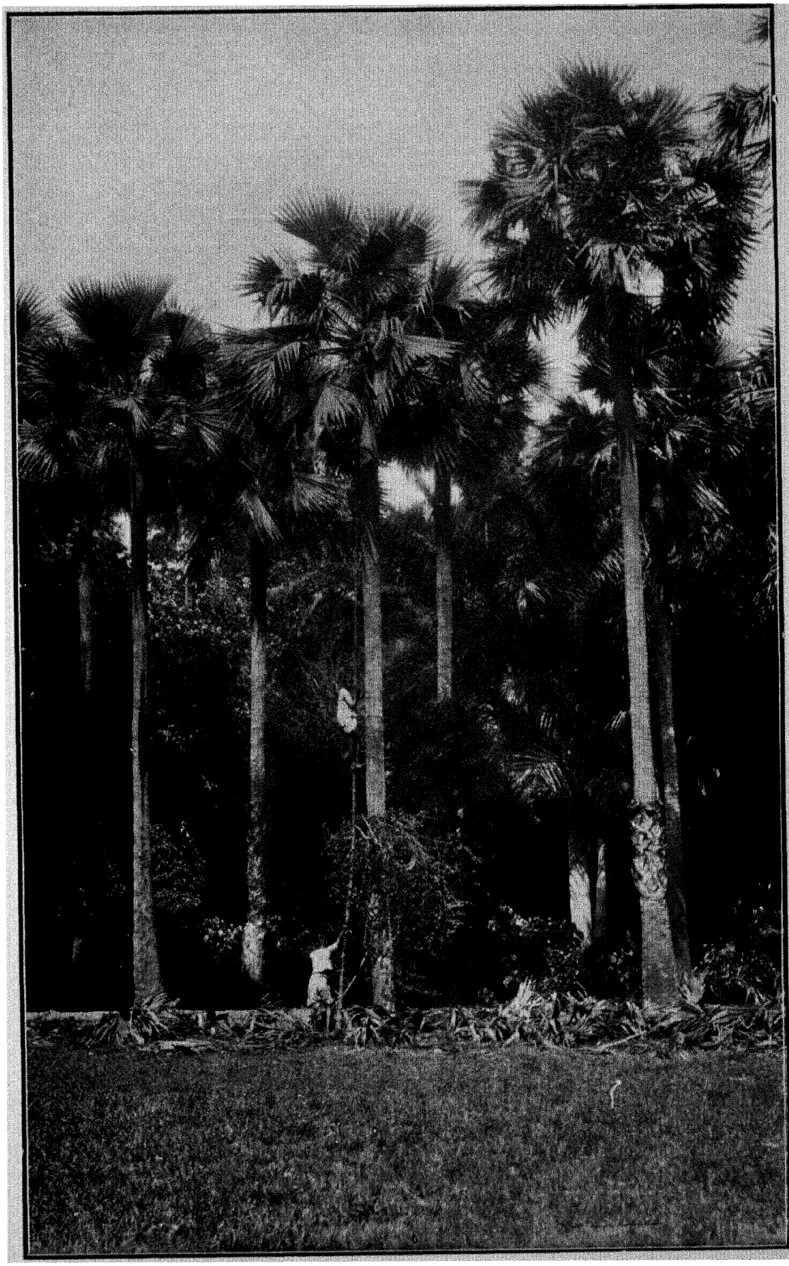
Pioneers of Indian Botany.—The development of Indian Botany started with the career of Dr. William Roxburgh, who was the first Botanist who attempted to draw up a systematic account of the plants of India. During his busy life in this country, he prepared a *Flora Indica* which contains a systematic description of all the indigenous plants known to him as well as of many exotics then in cultivation in the Royal Botanic Gardens, Calcutta, of which he was rightly chosen to be the first Superintendent in 1793. The *Flora Indica* was published after his death by Drs. Wallich and Carey in 1820 and was, for many years, the only book of reference regarding Indian Plants.

Dr. Roxburgh, who has been called the "Father of Indian Botany," was the first of a long line of famous men who have been associated with the Royal Botanical Gardens and who have contributed largely to our knowledge of Indian plants.

He was succeeded, as Superintendent, by Dr. Buchanan Hamilton and then by Dr. Nathaniel Wallich, an able and a most energetic Botanist, who, during the earlier part of his term of office, organised collecting expeditions into the then little known regions of Nepal, Sylhet, Tenasserim, Penang and Singapore. Dr. Wallich, in fact undertook a botanical survey of a large part of the Indian Empire. He was again followed by Dr. Griffith, Dr. Falconner and Dr. Thomas Thomson, a traveller and Botanist of much ability, the coadjutor of Sir Joseph Hooker in the collection and distribution of an extensive and well-known herbarium of East Indian plants and the joint author of the first volume of a new *Flora Indica.*

Flora of British India.—The publication of the "Flora of British India" was begun in the year 1872 by the distinguished Botanist Sir Joseph Hooker who travelled widely over India

PLATE II.



THE PALMYRA OR TODDY PALM (*Borassus flabellifer* **Linn.**)
An old Tamil poem enumerates 801 uses of this tree. A man is seen climbing one of the trees with the aid of a bamboo.

and whose work is still the standard Flora for the whole of India and which is too well-known to need further description. The names of Dr. Anderson, Mr. C. B. Clarke and Sir George King, during whose term of office the "Annals of the Royal Botanic Gardens" were first published, must also be mentioned, and of Robert Wight, M.D., F.R.S., author of the famous "Icones Plantarum Indæ Orientalis" and other works on Indian Botany.

Indian Botanists are indebted to Sir Dietrich Brandis, the pioneer of Indian Forestry for his volume on Indian Trees and to other forest officers, notably Kurz and Gamble who have published Forest Floras of different regions.

For a general account of the vegetation of this vast country with its varying climatic and edaphic conditions, the reader is referred to "The Sketch of the Flora of British India," by Sir J. D. Hooker and to the introductory essay to the *Flora Indica* by Sir J. D. Hooker and Dr. Thomas Thomson.

Systematic Botany.—Our knowledge of the systematic botany of the different regions in India is now fairly complete and for descriptions of the botany of the various provinces the reader is referred to such works as Kurz's "Flora of Burma," Prain's "Bengal Plants," Cooke's "Flora of the Presidency of Bombay" and Gamble's "Flora of Madras."

Herbarium at the Royal Botanic Gardens, Sibpur.—In the Herbarium at the Royal Botanic Gardens, Sibpur, Calcutta, probably the oldest and largest in the east, there is now a collection of about 1,400,000 plants which bear testimony to the energy of botanists in India. The Herbarium, with its excellent library, is the centre of reference for the whole of India.

Economic Botany.—The economic properties of Indian plants have been worked out in detail by Sir George Watt in his "Dictionary of Economic Products of India" and in his "Commercial Products of India."

Cryptogamic Botany.—Although our knowledge of Phanerogamic plants is thus fairly advanced, the study of Cryptogamic botany is still in its infancy except as regards the Filices, there being two outstanding publications on Indian ferns—Hooker and Baker's " Synopsis Filicum " and Beddome's " Ferns of India and Ceylon." The Moses and Liverworts have not been worked out at all. Attempts are now being made by Botanists of the different Universities of the Indian Empire and by others to work out these lower groups of plants. Already a considerable number of Algæ have been described and Dr. Brühl of Calcutta University and others are diligently pursuing this line of research. The Agricultural Department has undertaken the study of Fungi, especially those which attack the agricultural crops and Dr. Butler of the Pusa Institute has pushed a work on Fungi and Diseases in Plants. The Indian Tea Association's Research Institute at Toclai is investigating the diseases on Tea so that Fungi of economic importance are gradually becoming known.

Fossil Flora.—Indian Paleontology is being studied by Professor Sahani of Lucknow University.

Plant Physiology.—The investigation of the physiology of Indian plants is in the hands of the great physiologist Sir Jagadis Chandra Bose of the Bose Institute, Calcutta, whose ingenious apparatus, invented by him and manufactured by Indian workmen has gained a world-wide reputation.

Trend of Botanical Study in India.—The advance of our knowledge of Indian Botany in the near future will probably move along three main lines:—

First, although our knowledge of the systematy of the higher plants is well-advanced, we know comparatively little of their habitats and social life. The study of Ecology has undoubtedly received a stimulus by the recent publication of the British Empire Vegetation Committee. Considerable information

regarding the ecology of our forest areas is available in Forest Working Plans but the information is inaccessible as these have hitherto not been published for general circulation. The Universities may perhaps be induced to undertake methodical study of the ecology of non-forest areas. By the co-ordinating of the information already available with information which might be readily obtained our knowledge of the vegetation in India could be very rapidly increased. The possibilities in this direction have already been indicated by the publication of the Vegetation of Burma by Lord and Stamp, a publication which would not have been possible without the pioneer work of Forest Working Plan Officers.

Secondly, a vast field for research lies open to those workers who are studying the lower forms of plant life of which, as yet, our knowledge is most scanty. That this field of research is attracting students and others in our Universities is evidenced by the numerous publications in the "Journal of the Indian Botanical Society," which has been edited, since its inception by Professor Fyson, Principal of the Presidency College of Madras. The members of the Indian Botanical Society, founded in 1920 by eminent Indian Botanists, are principally University men.

Thirdly, the study of economic products, especially of plants with medicinal properties on which investigations are already being undertaken at the Tropical School of Medicine is engaging the attention of botanists to whom will fall the task of finding out where and in what quantities these are available and also the conditions under which they could be cultivated.

Meantime this brief survey of Indian Botany serves to show that, although India has numbered among her botanists men of world-wide reputation, there is still unlimited scope for the zeal and ability of those who follow.

XV.

A SKETCH OF THE GEOLOGY OF INDIA.

BY

E. H. PASCOE, M.A., SC.D. (Cantab.), D.SC. (London), F.G.S.,
Director, Geological Survey of India.

Three Geological Regions.—Geologically India may be divided into three regions: (i) the Peninsula; (ii) the Extra-Peninsular region, including Baluchistan, the North-West Frontier, the portion of the Punjab north-west of the Jhelum including the Salt Range, the Himalaya, Burma and the Andaman and Nicobar islands; and (iii) the Indo-Gangetic Alluvial Plain between the first two. The Shillong Plateau belongs to the Peninsular region.

Antiquity of Deposits and Physiography of the Peninsula.—The keynote of the history of the peninsula is immeasurable antiquity—antiquity even according to geological standards. This applies emphatically to the formation of the rocks themselves, but also in no small measure to their elevation above the sea to form land. Of the rocks, omitting a few small but highly interesting coast deposits, omitting the coal basins, and omitting a vast lava flood which poured over the older rocks, probably none is younger than the Cambrian, the earliest geological period in which organic remains are definitely recognizable. By far the greater bulk of the Peninsular rocks, however, date back to periods which have left no record of life upon the globe. Soon after the Cambrian period the whole of the Peninsular region was raised to form part of a

continental area. Land it became and land it has been ever since.

Dharwar System.—The oldest recognizable rocks are Archæan in age and have been assigned the name of Dharwar after the district in the Bombay Presidency where they were first studied. The Dharwar rocks include true sediments and lava flows, and these, of course, must have been deposited upon some floor. For many years it was thought that most of the gneiss, which covers such a large proportion of the Peninsula, represented this most ancient ocean floor upon which the earliest sedimentary deposits of India were laid down. During the past few years, however, it has been shown that much of the gneiss is the altered product of a molten magma which was intruded into the Dharwar sediments after they had been deposited; this gneiss, therefore, though of great age, must be looked upon as younger than the Dharwar strata. So much of the gneiss has been shown to be intrusive into the Dharwar that it is now impossible to point to any of it as being definitely a remnant of the primeval ocean floor of the Dharwar epoch—the floor which received the first sediments of which any record remains brought down by the rivers from that very early land.

Primeval Ocean Floor.—Nevertheless, an ocean floor there must have been or the Dharwar sediments could never have been deposited, and it seems unlikely that the junction between the sediments and the floor has everywhere been completely obliterated by the subsequent intrusion of molten rock. In places the lowest horizon of the Dharwars in contact with the gneiss is a conglomerate of what appear to be pebbles of the gneiss, and this was originally regarded as conclusive proof that the gneiss was the older of the two and had supplied pebbles to the Dharwar rivers. Most of these conglomerates are now regarded as subsequent to the induration and folding of the rocks and produced by fracture and relative movement, the so-called "pebbles" being merely fragments detached and

ground into more or less globular shape by the movement of the two uneven walls of the fissure against one another.

Mergui Series.—In the Tenasserim division of Burma are some ancient metamorphosed clays and volcanic material which are regarded as the probable equivalents of the Dharwar system. Amongst the fragments of a volcanic agglomerate were found a few rounded pieces of a granite which has not, so far, been observed *in situ.* These are interesting as being representatives of a rock older than the deposits in which they occur; if the correlation of this "Mergui series" with the Dharwar be correct, this granite is the oldest rock we definitely know of in the Indian Empire.

Dharwar Sea.—Of the extent of the Dharwar Sea we have very little knowledge; it covered the northern and probably also the southern half of Madras and stretched northwards at least as far as the alluvial belt. It probably covered the Shillong plateau and extended as far east as Burma. It is from the Dharwar beds that the Kolar and other great goldfields of Mysore and Madras derive their gold. Manganese, iron and copper are also valuable products from this very ancient system.

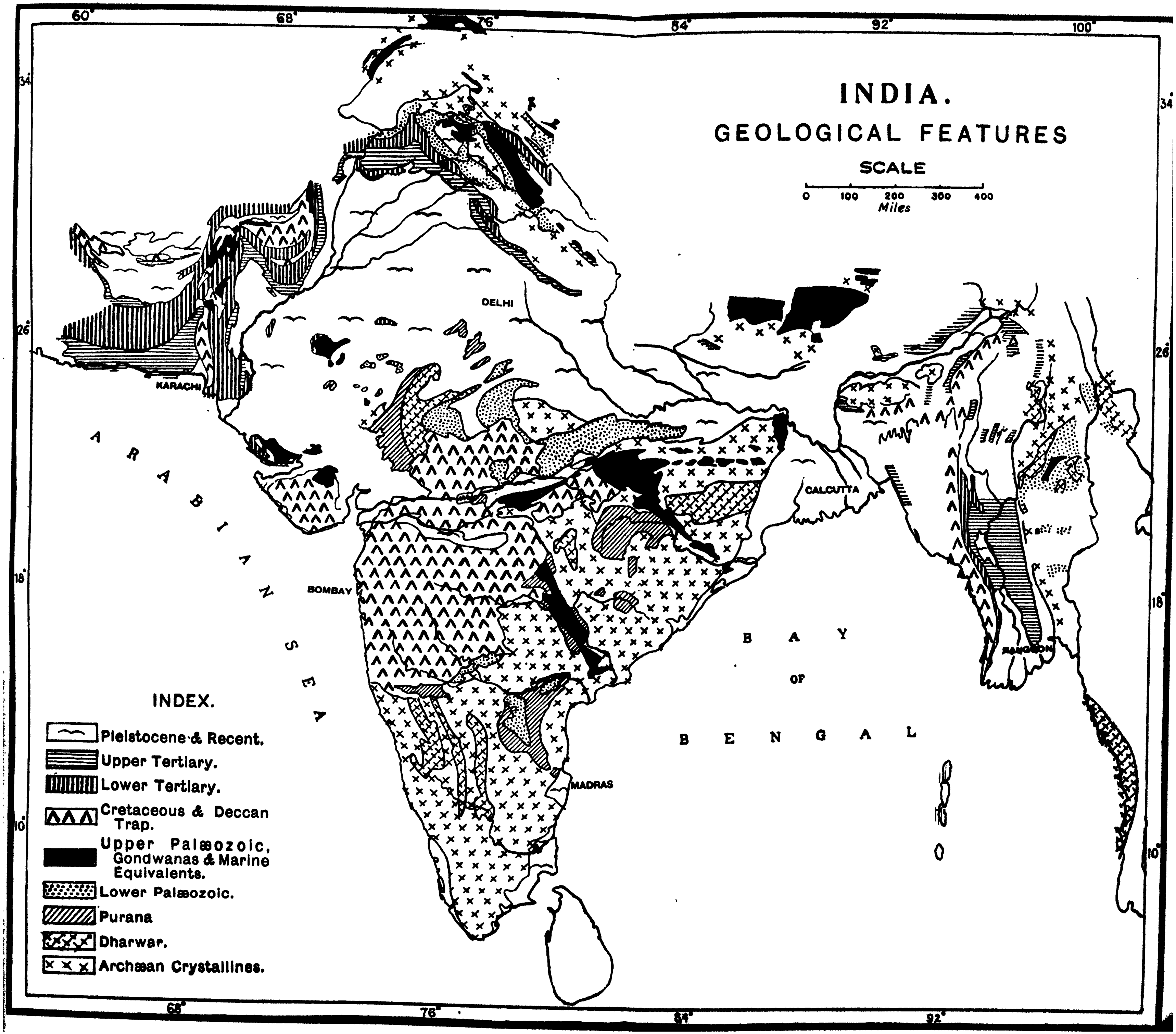
Folding Movement.—Whatever the mutual relationship between the Dharwars and the gneiss may have been, we know that the two were afterwards folded up tightly together by a compressional movement acting in a more or less E.-W. direction. The two groups were thus thrown into sharp folds running generally N.-S. but veering to N.W.-S.E. This folding movement was accompanied or followed by upheaval and the formation of land. Of the shape and extent of this land area—this forerunner of India—we know scarcely anything; the tightness and frequency of the folds, together with the enormous quantity of rock which must have been stripped off by subsequent denudation, point to lofty mountainous country which may have stretched far beyond the confines of the present peninsula. An immense period of quiescence then

ensued, during which the continent was subjected to atmospheric denudation so prolonged as to wear off almost all the old Dharwar deposits. The decrease in size and increase in isolation of the Dharwar outcrops as one passes south leads one to infer that the total area these beds now cover is not to be compared with that which they formerly occupied. All that now remain are relics of the troughs of a few of the compressed N.-S. or N.W.-S.E. folds, as the geological map shows.

Submergence.—During the next epoch, christened by Sir Thomas Holland the Purana, India sank again beneath the sea. Between this submergence and the end of the preceding one, the interval, known as the great Eparchæan interval, is thought to have been so great as to exceed the time which has elapsed since the first records of life on the Earth up to the present day.

Purana Epoch.—Upon the submerged and highly inclined edges of the denuded Dharwar and gneissic rocks were deposited a great thickness of sand, clay and limestone, which in the Cuddapah area of Madras amounted to some 20,000 feet. The outcrop of these beds in this basin, including the portion concealed beneath some overlying younger deposits, occupies an area of about 14,000 square miles. The Purana sea covered the northern half of Madras, the Central Provinces and Rajputana, and stretched probably as far as the Himalaya, and perhaps to Burma; in the last province the Purana may be represented by some of the rocks of the broad belt which lies between the gneiss of the Ruby Mines area and the fossil-bearing strata of the Shan plateau. The beds containing the vast and rich deposits of iron ore in Orissa and its Feudatory States are considered by some to belong to the Purana group.

Aravalli and Central Indian land : Vindhyan Period.—The next event seems to have been a corrugation of the sea floor by a movement having a direction N.W.-S.E. One of the effects of this movement was the initiation of the Aravalli


INDIA.
GEOLOGICAL FEATURES
SCALE
0 100 200 300 400
Miles
60°
68°
76°
84°
92°
100°
34°
26°
18°
10°
DELHI
KARACHI
BOMBAY
CALCUTTA
MADRAS
RANGOON
ARABIAN SEA
BAY OF BENGAL
INDEX.
Pleistocene & Recent.
Upper Tertiary.
Lower Tertiary.
Cretaceous & Deccan Trap.
Upper Palæozoic, Gondwanas & Marine Equivalents.
Lower Palæozoic.
Purana
Dharwar.
Archæan Crystallines.

Range in Rajputana, and here the folding was comparatively intense; elsewhere it appears to have been gentle and broad. This change ushered in the Vindhyan period and produced land in the Aravalli area; this we deduce from the absence of the earliest Vindhyan sediments along the flanks of this old mountain chain. Over a broad belt stretching from the Malwa plateau and the so-called Vindhyan Range to the Son Valley the Lower Vindhyan deposits consist predominantly of sandstone and clay. In the Son Valley they include volcanic ashes and more rarely lava flows, indicating the proximity of paroxysmal vents; similar volcanic deposits on a large scale are seen in the Rajputana desert west of Jodhpur. Further away from the Aravalli land area, over what is now part of Madras, the deposits comprise more limestone; the lowest beds are, however, coarse conglomeratic sandstone and were evidently derived from a not very distant coast. There is evidence of such land in the form of a broad flat ridge, parallel to the Aravalli ridge and distant from it some 450 miles away to the south-east. This more southerly ridge extended from the region south of the Son Valley through the Mandla, Seoni and Chhindwara districts of the Central Provinces, probably across Hyderabad to the Bombay Presidency. This ridge seems to have formed a barrier sufficient to separate two different basins of deposition, the Central Indian to the north and the Kurnool to the south. It is perhaps not entirely fortuitous that this ancient ridge, which has never since sunk beneath the ocean, still forms an important watershed in spite of the topographical changes produced by the Deccan lava (see p. 216); from the Amarkantak section of this ridge rise the Narbada flowing ultimately westwards, the Son flowing northwards and north-eastwards, tributaries of the Mahanadi flowing to the south-east, and the Wainganga and Wardha flowing to the south.

Earliest Organic Remains.—The most interesting feature of the Lower Vindhyan deposits is the occurrence in them in South Indore of organic remains. These have been pronounced

recently to be the chitinous shells of brachiopods allied to Cambrian forms of *Acrothele;* on this account the beds have been assigned to the Cambrian. These are not only the earliest known fossils of the peninsula, but the only marine fossils found in the peninsular area at all if we except a few isolated coastal deposits along the Coromandel and Malabar coasts, and a recently discovered exposure of Carboniferous in the Rewah State of Central India containing *Productus* and *Spiriferina.*

Extra-Peninsular Cambrian.—In extra-Peninsular parts of India the Cambrian is represented by definite faunas. In the Salt Range of the Punjab is a trilobite and brachiopod fauna of a very individualistic type but showing some affinity to Chinese, American and Australian forms. In the Spiti Valley of the Punjab Himalaya is another and more extensive fauna which, like that of the Salt Range, contains no species definitely recognizable in any other part of the world; it has, however, a marked resemblance to the Cambrian fauna of the Rocky Mountains. Its only link with the Salt Range is the trilobite, *Redlichia noetlingi.* In all probability these Cambrian beds extend through the Himalaya with possible interruptions at least as far as the frontier of Nepal. More doubtful occurrences of Cambrian strata are those of Kashmir and the Hazara district of the Punjab.

Lower Palæozoic of the Peninsula.—In the northern half of the peninsula the Lower Vindhyan series is invariably succeeded by the Upper Vindhyan. This is a sandstone series and yields the pink or purplish sandstone so largely used for building purposes. It was especially so used by the Pathans and Moghals; Akbar employed it in building his city of Fatehpur Sikri. The Upper Vindhyan must represent a later series of the Lower Palæozoic, but has so far yielded no determinable organic remains; its sandstones, however, exhibit records of "fossil weather" in the form of ripple-marking, sun-cracks and rain-pitting.

Ordovician.—Ordovician sediments overlie the Cambrian in Spiti, and contain a brachiopod fauna showing a clear relationship to the fauna of the American Chazy or Trenton formations. North-westwards the beds extend into Lahaul and are probably found in Kashmir. To the south-east Ordovician beds have been recognized in British Garhwal, where they contain a Spiti fauna. The best development of the Ordovician is seen in the Northern Shan States of Burma; here there is a rich fauna which, curiously enough, is much more closely related to that of North Europe than to those of the Himalaya (Spiti) and America. There seems to have been an effective barrier—presumably of land—between the Central Himalaya Ordovician sea and a sea stretching from North Burma through China and Siberia to Scandinavia. The central Himalaya sea was probably connected with the North American sea by way of Southern Europe through the forerunner of the present Mediterranean.

Silurian.—The Silurian follows the Ordovician in Spiti and Garhwal, and has been identified in Kashmir; its fossils have elements in common with the American fauna, but their predominating resemblances are with north European forms. Silurian beds with a fauna including a rich assemblage of graptolites succeeds the Ordovician of Burma. One continuous Silurian ocean seems to have spread round the northern hemisphere, including the old interior sea of North America, but to have been shut off from a precursor of the Pacific.

Devonian.—The only places where the Devonian system has been definitely identified are Chitral and Burma, but certain quartzites in Kashmir, Spiti and Garhwal, from their position above the Silurian, and some unfossiliferous beds underlying the Trias of the Hazara district, may provisionally find a place here. The Chitral beds contain characteristic brachiopods and corals, while the Burma strata contain a rich assemblage of Devonian forms, including the characteristic coral *Calceola sandalina.*

Carboniferous.—Carboniferous strata containing marine fossils have been found in the Salt Range, Kashmir, Spiti, Garhwal, Chitral and Rewah State; the same beds also occur in the Northern Shan States, the Tenasserim division and probably in the intervening tracts in Burma. The discovery of *Productus* and *Spiriferina* in Rewah State, Central India, is interesting as pointing to the invasion by the early Carboniferous ocean of the peninsular or continental area to this extent.

The Gondwana Continent.—Towards the end of the Carboniferous and the beginning of the Permian periods we find India forming part of a great southern continent stretching across the Arabian Sea and Indian Ocean, over the site of the Seychelles Islands to Madagascar and South Africa, and thence south-westwards to South America and Antarctica; to the south-east it was united to Australia and may have covered the rest of the Indian Ocean. To the north, girding the greater part of the Earth, was a latitudinal sea, the Tethys, of which the Mediterranean is a dwindled relic. The backbone of the Indian end of this old continent of Gondwanaland was the Aravalli Range, the oldest mountain range in India, which at that time must have formed a lofty snow-clad chain comparable to the modern Himalaya; from its south-eastern flank flowed glaciers which fed streams in whose basins the coalfields of India subsequently accumulated. The cold, however, was not confined to the mountain heights, for evidence of the proximity of glaciers in the form of ice-scratched and facetted boulders and pebbles is widespread over the whole continent from Australia to the Argentine and the Antarctic regions. This Arctic climate was followed by one less severe but still cold. A dense undergrowth of ferns and cycads, apparently of Antarctic habit, covered the land and gave origin to the beds of coal which characterize the strata which succeed the boulder beds; the best known of the ferns have been named *Glossopteris* and *Gangamopteris*.

The Tethys Sea.—Meanwhile the Tethys Sea persisted as the northern boundary of Gondwanaland and in Triassic times stretched from north-east of Darjeeling through Kumaon and Southern Tibet, Garhwal and Spiti into Kashmir and westwards into Europe across the Pamirs, Bokhara, Afghanistan and Baluchistan. Its course can be traced by deposits with Triassic fossils. North of it was a land-mass covering the greater part of China, Siberia and North Russia, to which the name of Angaraland has been given. Either a southerly prolongation of the Tethys or a separate sea occupied the greater part of Burma, for we find Triassic coastal deposits along the Arakan Yoma; to the west was land which in all probability was continuous with the Madras area over what is now the Bay of Bengal.

Separation of Africa from Asia.—It was probably during the Permian epoch that an arm of the Tethys commenced to extend slowly southwards along the Red Sea over that portion of the Gondwana continent which now forms the eastern margin of Africa. Whatever its time of commencement may have been, we know that during the following Triassic period it had penetrated as far as the north of Madagascar.

Jurassic.—During the next period, the Jurassic, the face of Asia changed considerably and the old Gondwana continent began to break up. The sea-arm from the Tethys pursued its way to form the Mozambique channel, separating Madagascar completely (for a time at least) from Africa, and then seems to have expanded eastwards to produce the major part of the Indian Ocean including the Bay of Bengal. The land connection between India and Madagascar was maintained still across the site of the present Arabian Sea. In some deposits along the east coast of Madras occur a few coastal fossils of Jurassic age, including an ammonite found in Madagascar and South Africa. This occurrence affords us a dim picture—amply confirmed by evidence from later deposits—of a free

sea connection along a continuous coast from this part of India to Madagascar. The Coromandel coast and a large portion of the Indian Ocean including the Bay of Bengal, therefore, date from the Jurassic era. In Burma sea and land seem to have changed places during this period, the Arakan Yoma forming a coast to the newly formed Bay of Bengal, while the eastern parts of Burma became land. This change was brought about by an E.-W. earth movement, initiating the N.-S. topography of Burma which has persisted to this day.

Cretaceous.—Of Cretaceous deposits we find patches along the east coast of Madras just as we do of Jurassic. From these younger beds, however, an extensive fauna has been obtained and this is identical not only with that of similar beds in Madagascar and South Africa but also with that of beds of the same age in the Shillong plateau of Assam, showing that the old Gondwana coast-line not only persisted from Madras to Madagascar but extended north-eastwards during the Cretaceous period as far as the Shillong plateau.

Deccan Trap.—Towards the end of Cretaceous times there commenced a period of disturbance and earth movement which brought about further striking changes in the geography of Gondwanaland. A movement from the north caused the recession of the already dwindled Tethys from Central Asia, and initiated the Himalayan chain and the Tibetan plateau along the northern coast of the continent. At the same time a continuation of the movement from the east elevated the Shan plateau and raised the Arakan Yoma above the level of the sea. These movements in their early stages were accompanied by the outpouring of floods of basaltic lava on a colossal scale. This lava, the Deccan Trap, was ejected through fissures in the Earth's crust and issued in such quantities that the relics to-day, after millions of years of denudation, cover over 200,000 square miles in the Bombay

Presidency, Hyderabad, Berar and the Central Provinces and Central India. Since the eruptions took place along the flank of the Aravalli watershed, they did not seriously disturb the drainage scheme of the area.

Early Tertiary.—During early Tertiary times the slow rise of the Himalaya along the Tethys coast produced along its southern flank a gulf which extended as far south-east as the meridian of Lansdowne. At its north-western end it curved southwards to enter the Arabian Sea which was formed about this time in the following way. As a result probably of earth movement, a large block of Gondwanaland west of what is now the Bombay coast was broken off and submerged beneath the waves. The age of the Malabar coast and the Arabian Sea is, therefore, probably early Tertiary; some small coastal deposits near Quilon with early Tertiary fossils confirm this. The straightness of this coast-line and its lack of indentation are due to this fracture or faulting and to its comparatively recent age. The same cause brought about the truncation of the Aravalli drainage, and for this reason all the important rivers of Madras and Southern Bombay are easterly flowing and rise within a few miles of the west coast; they are in fact but the lower portions of older rivers which rose in the old Aravalli watershed further west. The disjunction of the submerged part of the continent was assisted by faults in other directions; one of these seems to have coincided with the southern boundary of the Kathiawar Peninsula and to have initiated the Narbada, the middle section of which has an unusually straight course.

Petroleum Deposits.—In the early Tertiary gulf of the Punjab were accumulated the petroleum deposits which are now being exploited in the Pindigheb district. Similar gulfs, in which petroleum deposits were formed a little later on, were also produced further east, one passing up into Assam from the Bay of Bengal, and the other up what are now the

Irrawaddy and Chindwin valleys. Thus originated the Digboi oilfield of Upper Assam and the rich oilfields of Yenangyaung and Singu in Burma.

Initiation of Rivers.—As the Himalayan chain continued to rise, the gulf along its base became silted up and gave place to a river, the lower section of which coincided with part of the modern Indus. The gulf in Burma also silted up and was also replaced by a river coinciding with the present Irrawaddy and its chief tributary, the Chindwin. This old Chindwin-Irrawaddy River is thought to have been continuous with the Tibetan part of the Brahmaputra, the Tsangpo, which was subsequently captured by the backward cutting of the Brahmaputra proper, i.e., the Assam Brahmaputra. The compressional movement which piled up the Himalayan chain produced a deep trough in front of it which was simultaneously filled and is still being filled with river sediments. The movement is, in all probability, still persisting and the Himalaya still rising.

XVI.

THE WEATHER OF INDIA.

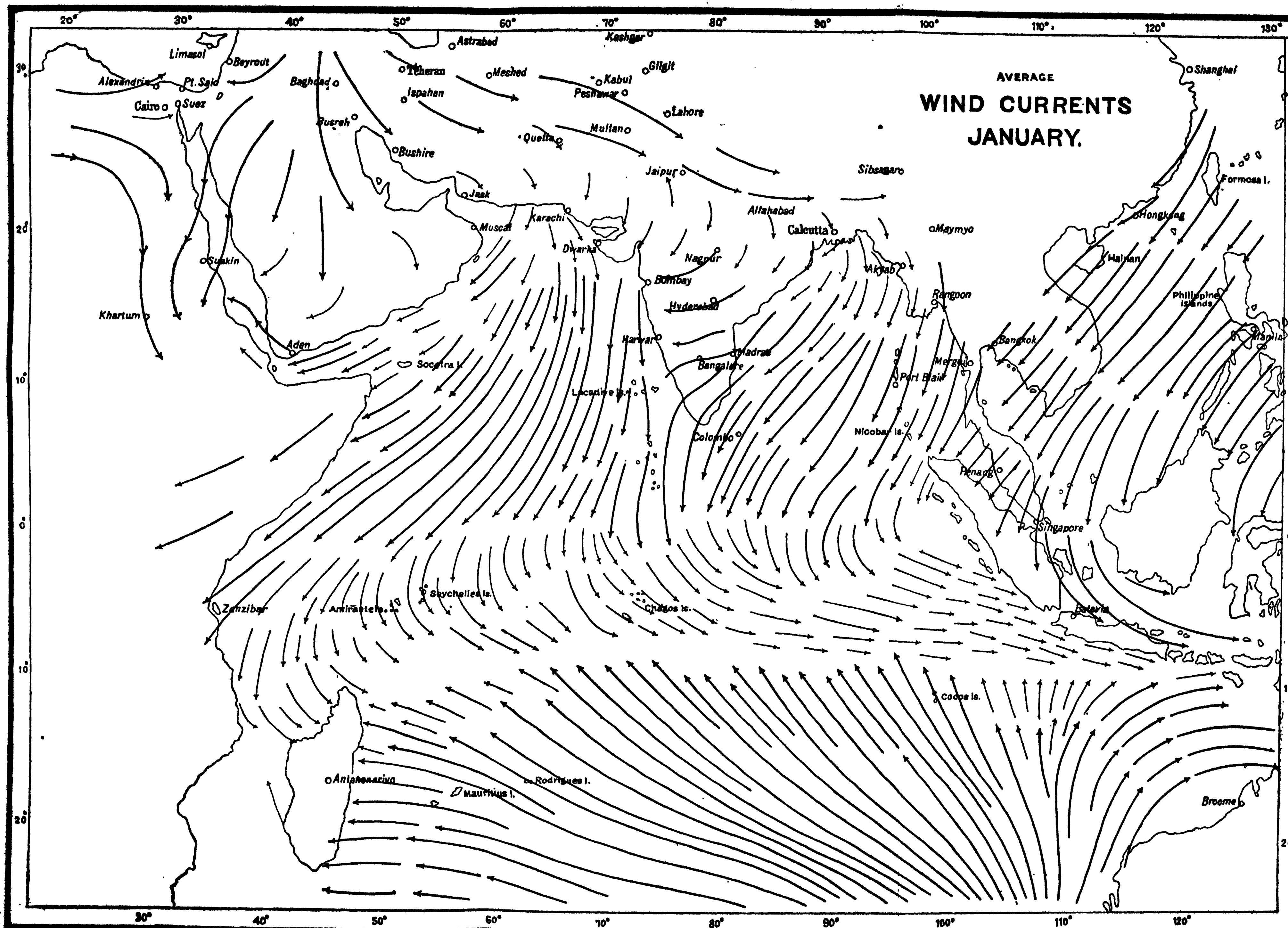
BY

C. W. B. NORMAND, M.A., D.SC.,
Director-General of Observatories, Simla.

1. Contrasts and Seasons.—India presents as great contrasts in meteorological conditions as any area of similar size in the world, and furnishes the typical large-scale example of the alternation of seasons known as monsoons. The contrasts are striking. In the north-west lies the great Rajputana desert with average annual rainfall of less than 5 inches; in the north-east is Cherrapunji with an average annual rainfall of 430 inches. The observatory at Dras in Kashmir has recorded a temperature as low as — 49°F.; that at Jacobabad has several times registered 126° and over. Hill stations in the Himalayas, such as Simla, may be shrouded in cloud for days together in September with humidities of 100 per cent., but in November may be overrun with air of practically zero humidity. The mean *annual* range of temperature at Cochin in South India, 20°F., is less than the *daily* range at many stations in North India and only about one-third of their annual range. During the winter third of the year the general flow of the surface air strata is from land to sea and thence over the Indian Seas as a *north-east monsoon;* it is a season of winds of continental origin and great dryness. The summer third of the year sees a complete reversal of this condition in a flow from sea to land of the moist winds of the *south-west monsoon;* this consequently is a season of much humidity and cloud and frequent rain. Between these

principal seasons of the year are the transitional periods of the *hot weather* months, April and May, and of the *retreating south-west monsoon,* October and November. The causes determining the monsoon currents are many and complex but the fundamental cause is certainly the difference of temperature in the winter and summer months respectively between Southern Asia on the one hand and the Indian Ocean and China Seas on the other.

2. **The north-east monsoon** is fully established in the Indian land and sea areas in the beginning of January, when temperature is lowest in the Asiatic continent. There is then a belt of high pressure with anti-cyclonic conditions stretching from the West Mediterranean to Central Asia and North-East China. Clear skies, fine weather, low humidity, large diurnal range of temperature, and light, northerly winds are the usual features of the weather in India during this period, broken only at intervals by weather disturbances which pass eastwards across Persia and Northern India, often into China. These disturbances are ordinarily less intense than, but similar in type to, the depressions of European latitudes. The precipitation accompanying them is small in amount, but very important for the winter crops. Some in their eastward passage give light rains over the whole of Northern India, while others which confine their activity to the extreme north give moderate to heavy rain in the Punjab plains and heavy snowfall in the higher Himalayas. The disturbances are attended with marked temperature effects, a rise occurring in front of them, while in the rear unusually dry clear weather prevails as a rule with stronger and cooler westerly winds. During this period of the year, rainfall is greatest in the north-west and decreases towards the south and east; dry weather prevails generally in the Peninsula and South Burma. The distribution of temperature is almost similar to that of rainfall, weather being colder in the north-west than in the east and south.

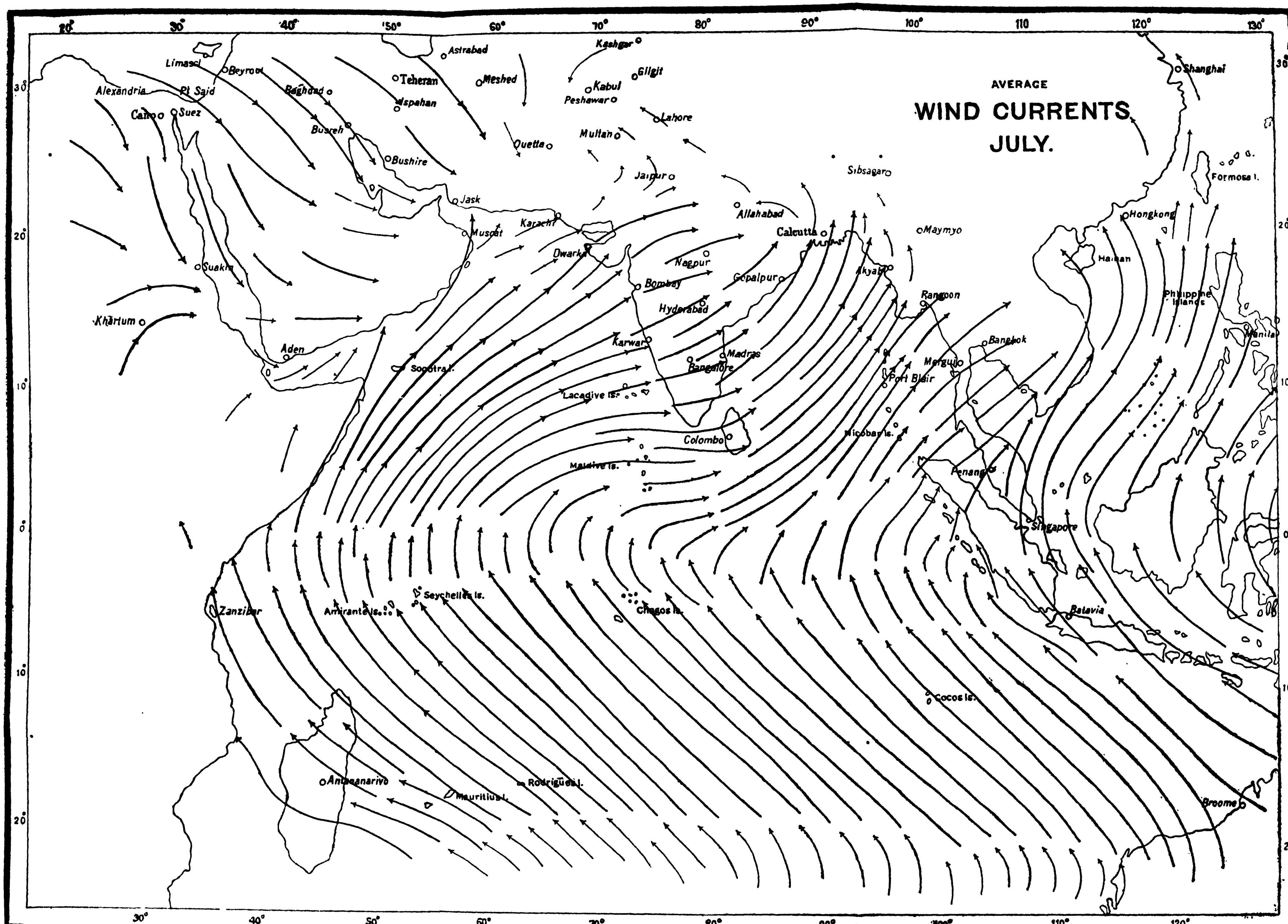

AVERAGE
WIND CURRENTS
JANUARY.
Limasol
Beyrout
Alexandria
Pt. Said
Cairo
Suez
Baghdad
Busreh
Bushire
Teheran
Ispahan
Astrabad
Meshed
Kashgar
Gilgit
Kabul
Peshawar
Lahore
Quetta
Multan
Jaipur
Sibsagar
Allahabad
Calcutta
Maymyo
Jask
Muscat
Karachi
Dwarka
Nagpur
Bombay
Hyderabad
Akyab
Rangoon
Suakin
Khartum
Aden
Socotra I.
Karwar
Madras
Bangalore
Bangkok
Mergui
Port Blair
Laccadive Is.
Colombo
Nicobar Is.
Penang
Singapore
Shanghai
Formosa I.
Hongkong
Hainan
Philippine Islands
Manila
Seychelles Is.
Zanzibar
Amirante Is.
Chagos Is.
Batavia
Cocos Is.
Antananarivo
Rodrigues I.
Mauritius I.
Broome

3. The hot weather period of March to May is one of continuous increase of temperature and decrease of barometric pressure in North India, of continuous decrease of temperature in the South Indian Ocean and adjacent land areas of Africa and Australia and of intensification of the southern anti-cyclonic high pressure area. There occurs a steady transference northward of the area of greatest heat in India, and simultaneously of the equatorial belt of low pressure of the winter season. In March the highest day temperatures, about 100°F., occur in the Deccan; in April the area of highest day temperatures, from 100° to 110°, lies over the south of the Central Provinces and Gujarat; while in May the seat of greatest heat is Northern India, and especially the north-west desert, where day temperatures of 120°F. or over are not infrequent. The area of lowest pressure also lies then over North-west India, with a trough stretching thence to Chota Nagpur. A local air circulation, with this trough as centre, exists over India and causes indraughts from the adjacent seas of southerly winds across the Bengal coast and of north-westerly winds across the Bombay coast. The land and sea winds give rise to large contrasts of temperature and humidity and consequently to violent local storms, especially in Bengal, where they are usually called "nor'-westers." These are sometimes of tornadic intensity and very destructive.

4. The South-west Monsoon.—Towards the end of May the air circulation over India becomes more and more vigorous, until, almost abruptly, the south-east trade winds from south of the equator are induced northwards into the Arabian Sea and Bay of Bengal and caught up in the Indian circulation. In most years this humid current, or the *south-west monsoon,* bursts on the Malabar coast during the first five days of June. It gradually extends northwards and is usually established over most of the Indian area by the end of June. The orographical features of India are of great importance in modifying the flow of the monsoon currents

and the distribution of monsoon rainfall. The mountain ranges to the east and north of India are equivalent to two sides of a box, through the other two sides of which the monsoon currents stream. The southerly or Bay of Bengal current is naturally deflected by the two sides of the box northwards through Burma, and then westwards up the Gangetic Plain. The Arabian Sea Current surmounts the Ghats on the west coast, causes copious rain there, advances over the Deccan and Central Provinces, and generally meets the Bay of Bengal current along the line of the trough of low pressure, which normally extends from Orissa to North-west India. Depressions which both intensify the monsoon rainfall and tend to concentrate it in their vicinity occasionally form in the north of the Bay and move along this trough. Further the trough is not stationary but moves north or south of the normal position and affects the rainfall distribution as it moves. Consequently the monsoon period is not one of continuous rain in any part of India. Bursts of general rain alternate with breaks partially or generally as the case may be. The pulsatory character of this action and of the rainfall precipitation is one of the most important features of the monsoon period meteorologically, as it is also economically for the proper growth of the crops. On the average, it may be said that the strength of the currents and the accompanying rainfall increase from June to July and remain steady till about the end of August. The monsoon then begins to retreat from Northern India. The table below shows the general distribution of rainfall month by month from May to October over the Indian land area:—

	Inches.
May	2·6
June	7·1
July	11·3
August	9·5
September	6·8
October	3·1
Total	40·4


AVERAGE
WIND CURRENTS.
JULY.
Limasol
Beyrout
Alexandria
Pt Said
Cairo
Suez
Baghdad
Busreh
Teheran
Ispahan
Bushire
Astrabad
Meshed
Kashgar
Kabul
Gilgit
Peshawar
Lahore
Multan
Quetta
Jaipur
Jask
Karachi
Muscat
Dwarka
Allahabad
Calcutta
Sibsagar
Maymyo
Akyab
Nagpur
Bombay
Gopalpur
Hyderabad
Rangoon
Suakin
Khartum
Aden
Socotra I.
Karwar
Madras
Bangalore
Lacadive Is.
Colombo
Maldive Is.
Port Blair
Mergui
Bangkok
Nicobar Is.
Penang
Singapore
Shanghai
Formosa I.
Hongkong
Hainan
Philippine Islands
Manila
Zanzibar
Amirante Is.
Seychelles Is.
Chagos Is.
Batavia
Cocos Is.
Antananarivo
Mauritius I.
Rodriguez I.
Broome

There are four important variations from the normal in the monsoon rains over the country; firstly, the commencement of rains may be considerably delayed over the whole or a large part of India: secondly, there may be prolonged break or breaks lasting over the greater part of July or August; thirdly, the rains may terminate considerably earlier than usual, and lastly the rains may be determined more largely than usual towards one part of the country than towards another. Consequences of the third variation are occasionally very serious and lead to disastrous famines, while the fourth constitutes the most common abnormality.

5. The retreating South-west Monsoon.—The second half of the wet season forms a transition period leading up to the establishment of the conditions of the dry winter season. This transition begins in the early part of October and is usually not completed until mid-December. The Arabian Sea monsoon current retreats southwards from Rajputana, Gujarat and the Deccan by a series of intermittent actions. The Bay of Bengal current retreats similarly down the Gangetic Plain. The low pressure conditions previously prevailing in North India are obliterated by October, are transferred to the centre of the Bay at the beginning of November and to the south of the Bay by the beginning of December. By the end of that month the belt of low pressure usually passes out of the Bay limits into the equatorial belt where it forms a permanent feature of the meteorology of the Indian Ocean during the next five months. Similar conditions obtain in the Arabian Sea also. This retreat is associated with dry weather in Northern India but with more or less general rain on the Madras coast districts and over the eastern half of the Peninsula, where October and November are often the rainiest months of the year.

6. Rainfall Variations.—From the foregoing description as well as from table A below, it will be understood that the distribution of rainfall over India depends largely on its

orographical features. If the hills and mountains of India were effaced, the country would receive much less rainfall and would not be able to support its present population. It will also be seen that the rainiest season in most provinces is the monsoon period, June to September; that rainfall during the cold weather is scanty but essential for the production of wheat crops over Northern India, and that the important rains in South-east Madras are those of October to December. Stress has also been laid on the great variability of monsoon rainfall in time and space in any one year. The variations in the amount of precipitation received from year to year are also surprisingly large. The annual rainfall of the Indian region, excluding Burma, is 40 inches and variations from this normal as great as + 9 inches and — 11 inches occurred in 1893 and 1899 respectively. Long breaks in the monsoon or an abrupt termination of rains is disastrous to crops and produces droughts or famines. These droughts occur particularly in the interior districts, the percentage variability of annual rainfall being 100 per cent. or even more in North-West India and parts of the Deccan. Droughts due to the failure of winter rains affect mostly the Punjab and the Gangetic Plain.

On the other hand, tracts of country are sometimes deluged with rain and suffer distress through excessive flooding. These heavy downpours occur chiefly near the tracks of the cyclonic depressions of the monsoon months or of the cyclones that occasionally advance inland from the Bay of Bengal or Arabian Sea. A fall of 10 inches to 20 inches in a day is by no means a rare occurrence. The heaviest ever recorded in the plains in 24 hours is 35 inches at Purnea in Bihar.

7. Cyclones.—At a time when the general meteorology of India was unknown, Henry Piddington laid the foundations of our knowledge of the storms of the Indian Seas and introduced the word *cyclones* to connote them. In these storms,

oval or circular in shape, the air moves in converging spirals in a left-handed direction against the hands of a clock. The winds become fiercer and fiercer as the centre is approached and reach hurricane force near it. In the innermost central zone of some ten miles diameter the wind suddenly falls off to a calm or light air, and the barometric pressure there often marks an inch, and sometimes as much as two inches, below normal. Cyclones generally die away soon after they reach land, but in the coastal districts which they touch may cause great havoc through high winds, torrential rain and, most destructive of all in low-lying districts, storm waves. The latter are due to the huge masses of sea-water swept forward by the storms and, when aided by a high tide, may inundate low-lying land to a depth of 20 feet. The storm wave accompanying the Bakarganj cyclone of 1876 was one of the most destructive on record; about a hundred thousand people were drowned in half-an-hour on the alluvial flats of the Meghna, while an equal number died from epidemics of fever, cholera and other diseases, which almost invariably follow a storm wave. The principal cyclone months in both the Arabian Sea and Bay of Bengal are May, October and November. They may also occur in April, September and December, and, particularly in the Arabian Sea, in June on the advancing front of monsoon air.

8. **Temperature and Climates.**—Temperature is perhaps, next to rainfall, the most important feature of meteorological observations in India from the economic standpoint. During one part of the year from January to May or June the increase of temperature by solar action is greater than the loss by radiation and other actions, and hence temperature rises more or less steadily in conformity with the increasing elevation of the sun. During the remainder of the year, the balance is the other way and temperature steadily decreases from June or July to December. Though, in most countries July and August are as hot as, or hotter than, June, the similar phenomenon is prevented in India by the cloud and

TABLE A.

Monthly and annual normal rainfall in subdivisions.

Subdivision.	January.	February.	March.	April.	May.	June.	July.	August	September.	October.	November.	December.	Year.
Lower Burma ..	0·12	0·23	0·55	1·42	12·30	25·79	29·77	27·50	17·61	7·85	2·71	0·54	126·39
Upper Burma ..	0·10	0·21	0·42	1·29	5·98	8·11	7·35	8·63	8·03	5·55	1·82	0·47	47·96
Assam	0·67	1·53	4·00	9 00	12·08	18·23	18·74	16·83	12·50	5·66	0·90	0·35	100·49
Bengal	0·34	0·95	1·67	3·25	7 64	14·62	15·14	14·26	10·89	5·08	0·79	0·16	74·79
Orissa	0·44	1·17	1·08	1·38	3·31	9·83	13·01	13 00	8·96	4·88	1·52	0·22	58·80
Chota Nagpur ..	0·77	1·15	0·93	0·70	2·13	8·97	12·91	13·77	8·10	2·92	0·39	0·14	52·88
Bihar	0·42	0·69	0·47	0 60	2·27	7·78	12·36	12·51	8·80	2·32	0·29	0·09	48·60
United Provinces, East	0·63	0·55	0 32	0·19	0·67	4·78	11·55	11·33	6·87	1·87	0·19	0·22	39·17
Do. West	0·96	0·89	0·61	0·30	0·68	4·06	11·47	11·14	5·96	0·88	0·15	0·36	37·46
Punjab, East and North	1·21	1·02	0·91	0·56	0·62	2·02	6·22	6·37	3·30	0·38	0·13	0·44	23·18
Do. South-west ..	0·50	0·53	0·64	0·52	0·42	0·81	2·47	2·56	1·11	0·10	0·08	0·21	9·95
Kashmir	3·71	3·54	4·60	3·45	1·93	2·53	7·26	7·86	3·60	1·05	0·48	1·97	41·98
N.-W. Frontier Province	1·28	1·19	1·89	1·54	0·77	0·86	2·58	3·16	1·18	0·33	0·28	0·54	15·60
Baluchistan ..	1 18	1·19	1·24	0·68	0 27	0 30	0·98	1 00	0·25	0·15	0·26	0·62	8·12
Sind	0·11	0·18	0·18	0·10	0·25	0·34	1·64	2·20	0·96	0·14	0·02	0·07	6·19
Rajputana, West ..	0·19	0·23	0 18	0·16	0·44	1·31	3·43	4 07	2·04	0·32	0·08	0·10	12·55
Do. East ..	0·37	0·31	0·24	0·17	0·52	2·62	8·31	8·14	3·96	0·52	0·16	0·22	25·54
Gujarat	0·09	0·10	0·07	0·03	0·33	5 15	12·61	8·11	4 64	0·91	0·20	0·04	32·28
Central India, West ..	0·38	0·30	0·16	0·15	0·47	4·78	10·52	10 97	5·21	0·80	0·41	0·16	34·31
Do. East ..	0·56	0·63	0·33	0·22	0·43	4·50	12·04	12·49	6·36	1·17	0·35	0·21	39·29
Berar	0·39	0·35	0·33	0·24	0·54	6·05	9·12	6·91	5 80	1·57	0·57	0·39	32·26
Central Provinces, West	0·65	0·71	0·59	0·31	0·59	7·39	13·44	12·91	7·60	1·82	0·56	0·30	46·87
Do. East	0·46	1·11	0·60	0·73	0·79	9·32	15·27	14·93	7·59	2·25	0·40	0·29	53·74
Konkan	0·10	0·05	0·06	0·36	1·55	25·31	39·09	23·99	12·53	4·30	1·01	0·13	108·48
Bombay, Deccan ..	0·15	0·08	0·15	0·63	1·35	5·22	7·85	5·44	5·61	3·02	1·01	0·28	30·79
Hyderabad, North ..	0·16	0·25	0·37	0·51	0·73	5·51	8·00	7·23	8·10	2·30	0·77	0·36	34·29
Do. South ..	0·18	0·24	0·42	0·81	1·02	4·33	6·24	6·31	6·82	3·02	1·06	0·22	30·67
Mysore	0·12	0·13	0·31	1·46	3·58	4·80	7·15	5·23	5·18	5·30	2·42	0·45	36·13
Malabar	0·92	0·57	1·50	3·84	7·39	23·82	21·50	12·16	7·85	11·33	7·36	1·86	100·10
Madras, South-east ..	0·98	0·47	0·51	1·29	2·53	1·56	2·19	3·61	4·48	7·10	7·47	3·38	35·57
Do. Deccan ..	0·20	0·14	0·21	0·62	1·67	2·36	3·21	3·91	5·75	4·18	2·18	0·41	24·84
Madras Coast, North ..	0·38	0·39	0·50	0·93	2·10	4·91	6·61	7·07	6·96	6·75	3·69	0·85	41·14

TABLE B.

Average $\frac{\textit{maximum}}{\textit{minimum}}$ *temperatures at 25 representative stations in India (in degrees Fahrenheit).*

STATION.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Trivandrum	84·0 **72·3**	85·6 **73·7**	87·6 **76·5**	88·0 **78·2**	86·7 **77·9**	83 1 **75·8**	82 2 **74·8**	82·5 **74·8**	83·1 **75·0**	83·0 **74·9**	82·8 **74·1**	83·3 **72·9**	84·3 **75·1**
Madras	84·5 **67·8**	86·8 **68·7**	89·8 **72·3**	93·1 **77·5**	98·5 **81·2**	99 0 **81·1**	95·9 **78·9**	94·2 **77·7**	93·1 **77·2**	89·4 **75·2**	85·2 **72·5**	83·4 **69·9**	91 1 **75·0**
Bangalore ..	80·8 **57·5**	86·2 **60·2**	91·1 **64·8**	93·5 **69·4**	91·7 **69 2**	84 9 **66·9**	82·2 **66·0**	82·0 **65·8**	82 3 **65·6**	82·1 **65·2**	79·8 **62·2**	78·9 **58·5**	84·6 **64·3**
Bombay	82·8 **68·2**	82·9 **68·6**	85·8 **73·2**	88·7 **77·4**	90·9 **80·8**	88·1 **79·8**	84·8 **77·9**	84·3 **77·3**	85 0 **76·9**	87·9 **76·9**	87·4 **73·8**	84·7 **70·0**	86·1 **75·1**
Poona	86·1 **54·2**	90·2 **56·2**	97·1 **62·8**	101·1 **68·9**	99·7 **71·9**	89·6 **72·6**	82 8 **71·0**	81·7 **69·6**	84 6 **68·6**	89·1 **66·5**	86 8 **59·4**	84 7 **53·9**	89·5 **64·6**
Hyderabad (Dn.) ..	84·2 **59·9**	89·7 **64·2**	96·7 **70·1**	101·2 **76·2**	103·1 **80·0**	94 5 **76·1**	87·6 **73·3**	85 8 **72·5**	86·4 **72·3**	88·4 **69·4**	84·5 **53·2**	82 4 **58·3**	90·4 **69·6**
Nagpur	83·5 **55·6**	88·5 **59·6**	97·4 **67·2**	104·8 **75·7**	108·6 **81·8**	98·9 **79·0**	88·1 **75·3**	86 8 **74·6**	89·1 **73·8**	90 6 **68·3**	85 6 **60·0**	81·7 **54·2**	92·0 **68·8**
Rangoon	88·6 **64·9**	92·3 **66·5**	95·9 **71·2**	98·0 **76·1**	91·7 **77·2**	86 4 **76·4**	85·3 **75·8**	85·0 **75·8**	85·9 **76·0**	87·6 **75·8**	87·5 **72·7**	87 1 **67·4**	89 3 **73·0**
Mandalay ..	84·5 **56·6**	90·3 **60·1**	98·1 **68·3**	102·4 **77·3**	99·8 **79·0**	94·8 **78·6**	94·7 **78·6**	93 2 **77·9**	93·1 **77·1**	92·0 **74·7**	87·7 **67·9**	83·5 **59·4**	92 8 **71·3**
Calcutta . ..	77·5 **55·6**	82·3 **60·3**	91·0 **69·4**	95·5 **75·7**	94·6 **77·6**	91·3 **78·8**	88·6 **78·7**	87 8 **78·5**	88·2 **78·1**	87·4 **74·5**	82·2 **64·7**	77·0 **56·0**	86·9 **70·7**
Silchar	77·9 **52·5**	80·5 **55·7**	85·9 **63·1**	87·7 **68·8**	88·7 **72·6**	89·3 **76·1**	90·0 **77·2**	89·6 **76·8**	89·8 **76·2**	88·6 **72·3**	85·0 **63·5**	79·6 **54·7**	86·1 **67·5**
Allahabad ..	74·4 **48·0**	79·5 **51·9**	91·9 **61·7**	102·8 **72·0**	106·6 **79·6**	102·1 **82·7**	92·8 **79·8**	90·0 **78·6**	91·5 **76·9**	91·1 **67·5**	83·4 **55·3**	75·7 **47·7**	90·1 **66·8**

TABLE B.—(*contd.*)

STATION.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct	Nov.	Dec.	Year.
Agra	74·2 **43·8**	78·5 **46·9**	90·2 **55·8**	101·7 **67·8**	107·5 **77·0**	105·6 **83·4**	95·0 **80·2**	91·7 **78·9**	93·1 **75·6**	92·9 **62·7**	85·5 **49·5**	76·9 **44·4**	91·1 **63·8**
Jaipur	74·5 **48·2**	78·3 **51·4**	89·1 **60·5**	99·8 **70·3**	106·1 **78·1**	103·6 **81·5**	94·7 **78·6**	91·4 **76·4**	93·9 **73·6**	94·5 **65·1**	85·9 **55·4**	77·2 **48·7**	90·7 **65·7**
Deesa	83·5 **51·4**	86·4 **54·3**	95·8 **63·1**	103·6 **71·3**	107·0 **77·4**	102·2 **80·5**	93·1 **78·1**	89·4 **75·9**	93·4 **74·1**	97·5 **66·9**	92·3 **57·9**	85·8 **52·3**	94·2 **66·9**
Karachi	76·1 **58·1**	77·6 **61·1**	81·8 **67·6**	84·8 **73·8**	88·9 **78·7**	90·7 **82·5**	88·4 **80·9**	85·5 **78·1**	85·7 **76·5**	87·6 **73·5**	85·0 **66·5**	78·2 **59·2**	84·2 **71·4**
Jacobabad ..	73·2 **43·7**	78·3 **48·6**	90·6 **59·8**	100·0 **69·9**	112·1 **78·7**	114·1 **84·7**	108·7 **84·8**	104·6 **82·1**	103·6 **76·5**	99·1 **63·7**	87·4 **52·0**	76·2 **44·2**	95·7 **65·7**
Lahore .. .	68·5 **41·5**	72·1 **45·0**	83·3 **54·6**	95·7 **64·6**	104·9 **73·7**	107·1 **80·5**	100·6 **80·7**	97·7 **79·3**	97·9 **73·8**	94·5 **60·8**	83·2 **48·4**	72·3 **41·1**	89·8 **62·0**
Rawalpindi ..	62·7 **38·1**	65·1 **41·3**	75·0 **50·3**	86·3 **59·1**	97·9 **68·3**	103·6 **75·7**	97·9 **76·8**	93·9 **75·4**	93·4 **69·1**	88·8 **56·6**	77·5 **44·2**	66·8 **37·4**	84·1 **57·7**
Peshawar ..	63·2 **39·4**	66·0 **42·6**	74·9 **51·5**	85·4 **60·1**	98·7 **69·9**	106·6 **77·3**	103·7 **79·6**	99·5 **78·1**	95·9 **70·7**	88·5 **58·0**	77·0 **45·8**	66·6 **39·0**	85·5 **59·3**
Quetta	51·2 **28·5**	53·2 **30·9**	63·6 **38·8**	73·7 **45·6**	83·8 **52·0**	91·1 **58·5**	93·4 **64·6**	91·6 **61·5**	85·9 **49·5**	75·5 **38·7**	65·4 **32·4**	56·0 **28·7**	73·7 **44·1**
Simla	46·4 **35·9**	46·8 **35·9**	55·2 **43·4**	64·6 **51·0**	72·1 **58·1**	73·1 **60·7**	68·9 **60·2**	66·7 **59·3**	65·8 **56·6**	62·7 **51·3**	56·0 **44·7**	49·8 **39·3**	60·7 **49·7**
Darjeeling ..	47·3 **35·1**	48·9 **36·1**	56·5 **42·3**	62·5 **48·4**	64·6 **52·3**	66·2 **56·5**	66·8 **58·0**	66·5 **57·6**	65·4 **55·9**	61·7 **50·1**	55·6 **42·8**	49·4 **36·7**	59·3 **47·7**
Pachmarhi ..	71·8 **47·6**	75·2 **51·0**	84·1 **59·8**	92·0 **69·3**	95·5 **75·0**	87·4 **72·1**	76·7 **68·2**	74·8 **67·0**	77·5 **66·2**	79·0 **59·5**	74·2 **51·0**	70·8 **45·8**	79·9 **61·0**
Ootacamund ..	65·6 **43·0**	67·4 **44·0**	70·0 **47·8**	71·7 **51·5**	70·2 **52·4**	64·3 **52·3**	62·1 **52·0**	62·9 **51·7**	64·4 **51·1**	64·6 **50·5**	63·6 **48·0**	64·8 **44·3**	66·0 **49·1**

XVII.

INDIAN ART.

BY

W. E. G. SOLOMON.
Principal, Sir Jamsetji Jeejibhoy School of Art.

THE present is a time of lively progress in art, as the visitor to India will easily discover for himself. The wonderful excavations by the Archæological Department in Sind bid fair to antedate our knowledge of Indian Art by many milleniums, and must tend greatly to modify the existing histories of this subject; while the vigorous public interest in art which has become prevalent in India (more especially in Western India) has converted "the Indian Art Renaissance" as it has been called, into something more than a mere figure of speech. This growth of interest in Indian Art is of very recent origin; Mr. E. B. Havell is frequently mentioned as the man who in the first place "started the ball rolling" by his well-known books, which re-awakened interest in the Art of Ancient India. But in fixing dates in this matter it would be safe to say that the inauguration of a School of Art in India (1854) was one of the first outward and visible signs that Indian Æsthetics and Art were to be encouraged once more after the dreary dearth of patronage which followed the palmy days of Shahjehan. In 1854, the "Sir J. J. School of Art," now the most comprehensive School of Arts and Crafts in India, was started on a very modest scale, through the liberality of the late Sir Jamsetji Jeejibhoy, first baronet, in Bombay; and soon other Government Art Schools were founded in Lahore, Calcutta, Madras and Lucknow.

Facts like these will be sufficient to apprise the enquirer, who may already know something about Indian Art, that the difference in the conditions which exist in the India of to-day as compared with those in the distant Past is in some respects comparable to that between Hellenic Art and the "Art Nouveau" of Europe! When one examines the paintings and sculptures of the Ajanta Caves which were produced during the first six centuries of the Christian Era, or allows one's imagination to run riot among the marvellous rock-cut temples of Ellora one can easily visualise ancient Buddhist and Hindu India as a vast Museum of Painting, Sculpture and Architecture. Even though Indian History between the tenth and the sixteenth centuries reveals an almost complete cessation of the practice of the Fine Arts for six hundred years, the Pageant of Indian Art is continued for us by the study of the Mohammedan revival, the flourishing period of Moghal Painting, and its parallel Rajput, or—as some prefer to term them—Hindu Schools. The glowing phases of Indian Art at which we have glanced have been periods in which—as in Europe—the patron played his part as strenuously as the artist played his. Shahjehan was able, we are told, to employ 20,000 men to build the Taj Mahal, and to spend enormous sums merely upon the scaffolding for the building—to say nothing of what was expended upon that most wonderful monument itself, facts which illustrate the achievements of the "gorgeous East" in the seventeenth century, and seem also to limit the possibilities of attainment in the prosaic Present. But having once succeeded in mentally adjusting these historical values, which are so palpably defined, the visitor to India will be able to realise (unless he belongs to the fortunately decreasing school of Pessimists) that Indian Art is in truth a modern actuality! It would be impossible within the scope of this brief survey to give even the most cursory description of the strange and complex beauty of the various Schools of Ancient Indian Painting. Varied though they are, through them all runs that highly individualistic point of view which seems to unite Buddhist Painting, Gupta Sculpture and Moghul Architecture as links in no common chain.

The hall-mark of India is indelibly stamped upon her artistic monuments, in spite of certain eclectic influences. It is only when we approach nearer to the present day that the current coin of Indian Art appears to be *noticeably* mingled with the alloy of "Foreign Influence." However, in Indian villages of the remoter districts, in some of the Indian Art Schools, and in Indian Art Exhibitions, this fundamental and distinct point of view which is so fascinating, so characteristically Indian, still exists—though always unorganised, and often unrecognised. Acquaintance with the country will make this miracle of an ancient art's survival no miracle at all, for a glimpse of an Indian Bazaar, or a view of a Religious Festival will reveal to us the persistence of this same deeply-rooted national viewpoint which permeates the domains of religion, literature and popular belief.

In Europe the vanishing Art Patron of the Middle Ages was partially if far less elastically replaced by the mobilised art patronage of the Academies. But in India both Academies and Salons are absent, and the small but lively Art Societies are the chief points of focus for anything like organised effort in the Fine Arts. The Simla Fine Arts (the oldest), the Bombay Art Society (the largest) and the Art Societies of Calcutta, Madras, Andhra (Southern India), Naini Tal, and others hold annual exhibitions of pictures, sculpture, architecture and photography. Public opinion in Art is chiefly *felt* in India to-day in Bombay and Western India, which may well be termed the cockpit of controversies on this subject, and where public interest in art is really strongly developing. Bengal is still the spiritual home of "Belles Letters," and the excellent books on art which emanate from that poetic Province demonstrate the interest of at least the intellectuals in the subject; while the paintings of Avanindranath Tagore, Nand Lal Bose, and others are justly celebrated in India and Europe. These are main and easily attainable channels of Art Culture in India to-day. It is in the backwaters—those still reaches, untroubled by the ripples of Modernism—that the active but inarticulate Art of India most widely, if silently manifests itself. Not everyone—indeed very

few Europeans—can find their way into the deep jungles, to track to his haunt in the forests of Kanara, or on the plains of Sind, or in the remoter regions of Southern India the true survivor of the artist-stock of Ajanta. The beautiful products of these hidden and humble but highly talented men and women (so inevitably exploited by the middlemen) can only be seen within the towns (ivories, woodcarving, embroideries, etc.); where they can be purchased at five, eight, or ten times the price which the patient genius who executed them received for the work. Hence the value of the Indian Art Schools as hunting grounds for the seeker after Indian talent, for an Art School naturally acts as a magnet to the more ambitious of the fraternity of the indigenous artists of India. In the Bombay School of Art, for instance, are congregated over six hundred Indian students of Mural Painting, Portrait Painting, Designing, Modelling, Carving, Carpet Weaving, Brass and Iron Work, Engraving, Jewellery and Architecture. Even if one is inclined to endorse the fierce disapproval of Art Schools (as a genus) by such determined critics as Segantini, the artist, or George Moore, the writer, it is still essential to pay these centres of juvenile talent a visit if one would understand the trend of the Indian genius in the arts and crafts to-day. Such a visit has converted many a pessimistic theorist into a practical optimist as to the future of Indian Art.

As to those present-day controversies on Indian Art which are so strongly agitating the public in Western India, and distracting the learned of Bengal and Madras—the most casual visitor to some of the centres of art education mentioned will probably discover that there is but *one* controversy on Art. The Western stranger in India of course wants to see Oriental Art, which, so far as painting is concerned, he does not very often buy—unless it carries a date with it! On the other hand the Indian patron often prefers Western pictures and portraits. So the Indian artist (after the approved manner of his kind the world over) paints for preference work that is wanted, and ignores the accusations of those who have recently discovered that an Artist if he happens to be Indian *must* paint in "Indian

Style." The issue between these two—the silent ability of the Indian Artist *versus* his extremely voluble public critics will amuse, if it fails to instruct, the casual enquirer. To the artists, however, such a controversy—as every artist knows—may easily reach a point at which it adds one more burden to the shoulders of those whose calling is already—in India especially—sufficiently onerous. Such being the case the best and most sympathetic course is to recall and apply the Poet's tribute to wise Sir Joshua Reynolds:—

> "When they talked of their Raphaels, Correggios, and stuff,
> He shifted his trumpet, and only took snuff!"

XVIII.

MEDICAL, RESEARCH AND EDUCATIONAL INSTITUTIONS IN INDIA.

In such an extended and thickly populated country as India there are naturally a very large number of institutions, medical and otherwise. So far as medical institutions go we may classify them as Hospitals (including also Special Hospitals, Mental Hospitals, Leper Asylums, Sanatoria, etc.), Medical Colleges and Schools, Medical Research Institutions with Pasteur and Vaccine Institutes and Public Health Laboratories, Medical Health and Research Associations and Societies, and in respect to Veterinary Science, Veterinary Research Institutes, Veterinary Colleges and other Veterinary Institutions. In addition to medical and veterinary institutions proper are institutions of a scientific character other than medical, some having a definite relation to medicine such as the Chemical Examiners' Departments, Agricultural Research Institutes, Meteorological, Zoological and Botanical Institutions, etc. There are again general educational and other institutions which may have an indirect bearing on Medicine such as Science and Technical Educational Institutions, the Universities and Colleges, Learned Societies, Libraries, Museums, etc.

In what follows a very brief account is given of the more important of these various institutions, more especially the purely medical, from which the method of origin and nature of activities, etc., of such in general may in some small degree be gathered. The accounts, however, are far too brief (which was unavoidable) to give a true view of the often highly individual activities of these bodies, a defect which the reader may allow for if he sees at work even an ordinary District or Mission Hospital in their due setting. Nor can the section even claim completeness within the limits stated above, for owing to briefness of time available for the compilation of such a note, very many important institutions

worthy of mention must undoubtedly have been entirely omitted, there being no easy method of obtaining a complete list of such known to the writer. In putting forward the section the writer desires to express his thanks to the Local Secretaries who furnished him with lists and suggestions and also to those in charge of Institutions, etc., who were good enough, no doubt often at some inconvenience or loss of time, to write brief accounts for inclusion. These accounts, owing to the demands of space, in some cases have been a little curtailed, but it is hoped nothing of importance has been omitted. Space has also made it desirable in these short accounts to omit mention of the names of those in charge or upon the staff except in a very few cases where there was some very special reason for doing so.

1. HOSPITALS, SPECIAL HOSPITALS AND DISPENSARIES.

Hospitals are naturally most aggregated in the large Presidency Cities but there is generally at least one largish hospital at the headquarter town of a district. Besides these there are dispensaries many of which have accommodation for a certain number of in-patients. The number of such public hospitals and dispensaries in India was, in 1924, 3,669 and the number of patients treated annually approximately 40 millions (in-patients 657,820, out-patients 37,401,566). There are in addition to the above the numerous Military Hospitals (British and Indian Station Hospitals, Family and Cantonment Hospitals, etc.), a large number of Mission Hospitals and privately endowed hospitals, as also hospitals in connection with Jails, Police, Canals, Railways, etc. The total number of State special, Railway and private owned non-aided Civil Hospitals and Dispensaries was in 1924, 1,506 and the number of patients treated by these 8,205,784.

There are 22 Mental Hospitals in India accommodating in 1924 9,712 patients (7,771 male, 1,941 female). A peculiarity of India is the existence of special hospitals for purdah women. Arranged by Provinces the following are hospitals or such like institutions that for one reason or another may be specially mentioned.

ASSAM.

Welsh Mission Hospital, Shillong, was opened in 1922 and is situated in a good climate at an elevation of 5,000 feet. It has 150 beds, a European block, maternity ward, X-rays, electro-therapeutics, modern operating theatre, modern sanitary arrangements. There are 40 Khasi nurses working under the supervision of three European sisters. Nurses attend both male and female patients; there are no dressers and no sweepers. There is hot and cold water, modern bathrooms and electric lighting throughout.

Patients from all parts of Assam are treated. Cases of enteric, *B. coli* infection and tuberculosis are prevalent. Gastric and Duodenal Ulcer, Urino-genital and Orthopædic work, as also Gynæcology and Obstetrics are prominent features.

Tezpur Mental Hospital, Tezpur, Assam, accommodates 441 patients but after reconstruction, which is now proceeding, room for 850 will be provided. In many ways its population is unique owing to the large coolie population imported from other provinces in India, and to the inclusion of many hill tribes within the administrative limits of the province. The tribes and castes which this hospital receives include the following: Assamese proper, residents of Sylhet and Cachar, coolie castes, hill tribes, e.g., Duffla, Aka, Abor, Miri, Mishmi, Nagas, Manipuri, Kuki, Lushai, Khasia, Gara and Mikir. The language difficulty here must be obvious.

Special Kala-azar Ward at the King Edward VII Memorial Pasteur Institute and Research Institute.—Refractory cases of kala-azar who have failed to obtain a cure at treatment centres are largely dealt with. The ward is very popular and the latest knowledge in the treatment of kala-azar by antimonial compounds is always to be found here.

Field Kala-azar Treatment Centres.—These are centres, many of them temporary and lasting only so long as the prevalence of kala-azar calls for them, scattered throughout the kala-azar affected areas of Assam. They are placed in the rural areas as well as in towns and are made therefore especially accessible.

Over 50,000 cases of the disease, the majority of which are permanently cured, are treated annually.

BENGAL.

Medical College Hospital, Calcutta.—Originally started in 1838. Enlarged in 1852 when it was moved to its present site. Now has over 300 beds. The Eden Lying Hospital, the Ezra Hospital for Jews and the Eye Infirmary were subsequently added to it. Closely associated with it are the Calcutta Medical College and Calcutta School of Tropical Medicine with its special wards. Much of the famous work of Sir Leonard Rogers was carried out at this hospital.

Presidency General Hospital, Calcutta.—For Europeans. Contains accommodation for 233 patients. Attached to this hospital is a small laboratory where Sir Ronald Ross carried out experiments with proteosoma which solved the great malaria problem.

Campbell Hospital, Sealdah, Calcutta.—Has associated with it the Campbell Medical School. Started in 1867. Is the largest hospital in India with accommodation for about 800 patients.

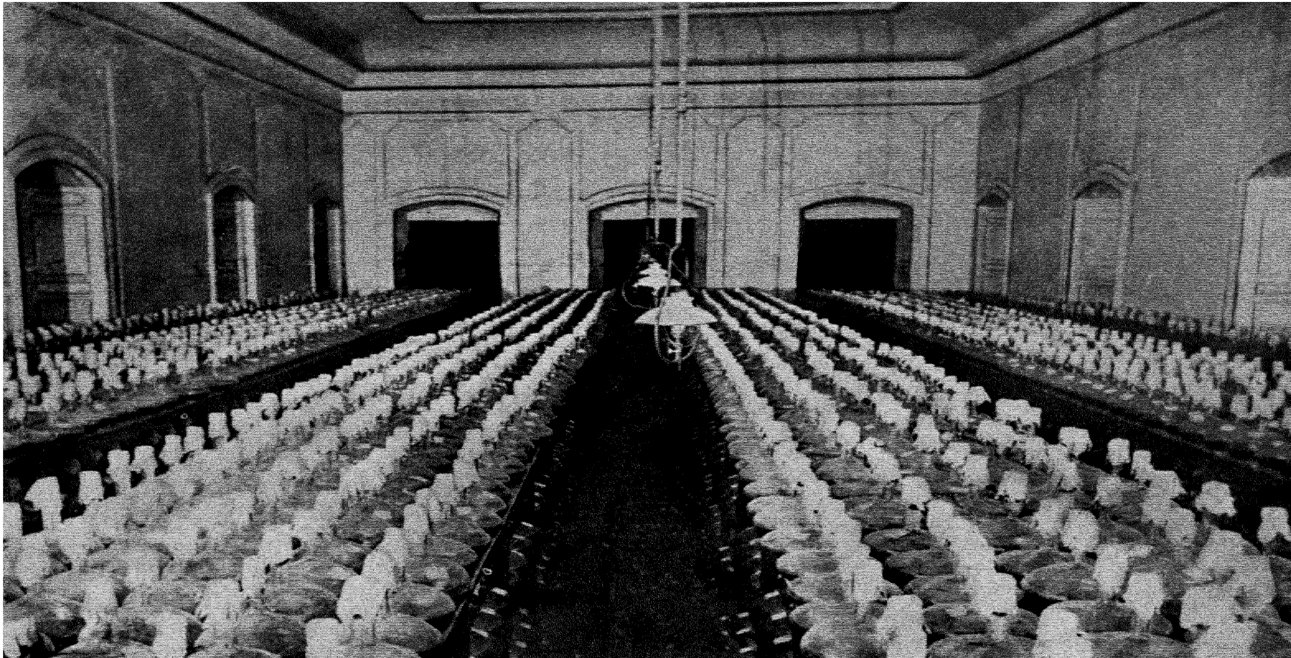
Albert Victor Hospital.—Associated with the Carmichael Medical College, Belgachia. Has accommodation for 100 beds.

BIHAR AND ORISSA.

Ranchi Indian Mental Hospital.—Ranchi is the summer capital of the Government of Bihar and Orissa. The Mental Hospital is at Kanke 8 miles from Ranchi and 2,300 feet above sea level. The Hospital covers 110 acres and accommodates 1,500 patients (1,200 male, 300 female). The Hospital serves the Provinces of Bengal and Bihar and Orissa and admits all certified criminal and non-criminal mental cases for treatment as well as voluntary cases.

The Male section consists of 10 "Q. P." (Quiet Patients) blocks well fitted with modern appliances, a Refractory Block and well equipped Infirmary with modern operating theatre. All these

PLATE III.



The Incubating Room.
(Plague Section, Haffkine Institute.)
Represents over a million doses.

buildings are provided with the latest sanitary arrangements and electric light with electric fans in the Infirmaries. The Female section consists of a Q. P. Block, Refractory Block and Infirmary of the same size as in the Male section. The Hospital has its own water supply, electric power house, post, telegraph and telephone offices, a dairy farm and an enormous vegetable garden. The medical staff consists of 7 medical officers, the medical superintendent being an officer of the Indian Medical Service. The staff includes a lady doctor, matron, 2 nurses and 4 compounders including a female compounder. The attendant staff is 400 including 68 females.

The Purulia Leper Homes and Hospitals.—Are situated 201 miles almost west of Calcutta on a fine wooded down 760 feet above sea level in the district of Manbhum in Chota-Nagpur. An easy night's journey by the Bengal Nagpur Railway from Calcutta.

The Homes were founded in 1888 by the Rev. H. Uffmann of the Lutheran Church, who received guidance and all the necessary financial support from the Mission to Lepers of London, England. The property to this day continues that of the Mission to Lepers and almost two-thirds of the financial support annually needed for maintenance is supplied by that Mission. From 1915 onwards, the non-Indian staff has been supplied by the Church Missionary Society of London and the superintendent has been an English ordained missionary. In 1926 a fully trained English nursing sister arrived and this year a qualified English lady resident doctor.

The effort to eradicate the disease has shown the usual alternations of hope and defeat seen elsewhere. Two members of the Leprosy Commission of 1891 gave the institution very high praise. In 1904 Captain Rost's 'Leprolin' was reported to have completely cured some anæsthetic cases and greatly improved more advanced ones. In September 1912 Colonel Drury reported some improvement had been noted in most cases in which the 'Nastin' treatment had been employed. In 1913 however this treatment was dropped as it is said the patients objected.

'Leprolin' was tried in 1914 but 'no benefit has been apparent.' In 1915 'Nastin' was again tried with 'doubtful results.' Also Anti-Leprosy Vaccine on 74 cases "with a beneficial result in most cases." In 1916 'Alouni,' a preparation of chaulmoogra oil from Switzerland, was used on 60 cases; 'in some cases apparently with considerable benefit.'

Dr. Heiser's treatment by intramuscular injections of chaulmoogra and also Sir Leonard Rogers' Gynocardate of Sodium and Potassium hyperdermic injections was suggested and of Dr. Heiser's treatment in 1917 'in some cases considerable benefit has been derived.' In 1919, 54½ per cent. in eleven cases strictly observed had markedly improved under Heiser's treatment.

In 1920, 67 cases were put on Sir L. Rogers' Gynocardate of Sodium injections. 'Some showed decided improvement. The genuine results are stated to have been rather disappointing.' Also 6 cases were given Margampuli—a preparation made from the Nim tree. A 'genuine improvement is noted in most cases.'

In 1921 Dr. Muir of the School of Tropical Medicine, Calcutta, began his regular visits to the Homes and E. C. C. O. treatment was commenced on a large number of cases. 400—500 cases received voluntary treatment once a week. From this time to the present practically all the experiments with various treatments at the School of Tropical Medicine have gone on here also. Sub-Assistant Surgeon Isaac Santra was appointed by the Bihar Government as Research Worker at this Hospital in 1923 and the Wheeler Research Room opened the same year. From 1921 to date 99 patients have been discharged 'symptom free.' During the same period no less than 82,453 injections have been given and at present extensive experiments are being carried out with Potassium Iodide also.

There were 601 lepers resident in August this year, besides 66 out-patients attending twice weekly from the neighbourhood, and 63 healthy or recovered children of lepers resident in our Healthy Children's Homes situated at a distance from the rest of the Leper Colony. A lakh of rupees has been spent on new buildings in the last 18 months and the Annual Maintenance

Expenditure now reaches to Rs. 59,000 plus the cost of three missionaries' allowances.

The following are some statistics of treatment.

Results of the Anti-Leprosy Treatment at Purulia Leprosy Hospital.

	1921.	1922.	1923.	1924.	1925.	1926.	1927.
Number treated ..	400	81	148	283	214	256	278
Symptom free ..	11	4	8	48	14	19	18
Marked improvement	..	..	25	58	12	18	20
Improvement ..	..	..	54	86	80	138	130
Stationary ..	..	..	17	57	45	68	75
Getting worse ..	..	..	44	34	63	13	15
Number of inject. ..	15,626	7,072	3,780	13,524	13,030	17,210	12,210

Total number of injections 1921 to July 1927, 82,453.

Total number of patients discharged as Symptom Free, 99.

BOMBAY.

St. George's Hospital (European General Hospital), Bombay.—The foundation stone of the present building was laid in 1889. The Hospital occupies a very central position near the Alexandra Docks and Victoria Station. It has general and special wards and is equipped in an up-to-date manner. The Convalescent Home in connection with this hospital is situated on the Hill Station Khandalla. The St. George's Hospital Nursing Association provides a large staff of nurses for the hospital and also for private out-door work.

The Sir Jamsetji Jeejibhoy Hospital.—Built in 1845 at the joint expense of Sir Jamsetji Jeejibhoy (first baronet) and the East India Company. Has 250 beds and gives accommodation mainly for the poorer Indian population of all classes. It has special buildings for male Parsi patients and for chronic cases. Adjoining are the Sir Cowasji Jehangir Ophthalmic Hospital, the Bai Motlabai Obstetric Hospital, Petit Hospital for Women and Children and the Dwarkadas Lulloobhoy Dispensary. The

hospital with those adjoining gives clinical facilities to the Grant Medical College. There is a Nursing Association under charge of the Sisters of All Saints. There is a fine operation block known as the Moore Operation Theatre.

Goculdas Tejpal Hospital.—Opened in 1874. It is a general hospital for Indian patients of all denominations. With the addition of the new Prince of Wales Wards opened by His Excellency the Governor of Bombay on 2nd March, 1927, there is accommodation for 240 beds. Besides the superintendent and resident medical officer there is an honorary staff consisting of Director of Medical Unit, one Director of Surgical Unit, one Radiologist, one Bacteriologist, one Pathologist and one Chemical Pathologist. Students from the Grant Medical College attend for clinical instruction in Medicine and Surgery. Under an expansion scheme it will shortly be a post-graduate teaching centre recognised for the purpose of post-graduate study for the degrees of M.D. and M.S. of the Bombay University.

King Edward VII Memorial Hospital.—This Hospital subscribed to by the people of Bombay as a suitable memorial to His Majesty King Edward VII is situated in the rapidly developing northern extension of Bombay. It was formally opened by His Excellency Sir Leslie Wilson, Governor of Bombay, on 22nd January, 1926. It is designed on the pavilion system and accommodates 334 beds. Its large verandahs are covered in and included in the wards so as to accommodate at least 100 more beds in case of emergency. Excluding the value of the free site, the hospital has cost about Rs. 38 lakhs to construct and about Rs. 5 lakhs to furnish and equip. Associated with the Hospital is the Seth Gordhandas Sunderdas Medical College endowed by the Trustees of the late Seth Gordhandas Sunderdas (*see* Medical Schools).

Sir Cowasji Jehangir Ophthalmic Hospital, Bombay.—Was built in 1866. Is intended for the medical relief of poor people suffering from eye diseases. It is named after Sir Cowasji Jehangir who contributed very largely towards the erection of the building. The present Baronet also made a further large contribution towards the new wing added in 1909. There are 8 wards with 73 beds. The out-patients number over 200 per day. The

whole Hospital has been brought up to date with modern and latest appliances. It is affiliated to the University of Bombay as a teaching institution for M.B., B.S. and D.O. students and post-graduate students of the Grant Medical College.

Cama and Allbless Hospitals for Women and Children, Bombay.—These institutions are entirely staffed and managed by women. The existing accommodation is for 150 beds. Maternity and its complications represent the special feature of the work. A day is set apart for Venereal Disease clinics and ante-natal work. This treatment is very popular and is carried out in the Out-patient Department where the daily average number of patients exceeds 120. A large number of women living in the city and suburbs, and especially those classes who wish to be treated by women, take advantage of the Hospitals.

Nowrosjee Wadia Maternity Hospital, Bombay.—This Hospital situated close to the Seth Gordhandas Sunderdas Medical College was started to give facilities for confinement to women of labouring classes in Bombay, particularly in the Mill Industry and to give training in Midwifery to Medical Students and Nurses. It was founded by Sir Ness Wadia in 1922 and financed by him until the end of 1926 when it was taken over by Government and the Bombay Municipality. It has 135 beds of which 10 are set aside for delivery.

Arthur Road Isolation Hospital for Infectious Diseases, Bombay.

Police Hospital, Bombay.

Sassoon Hospital, Poona.

Civil Hospitals at Karachi, Belgaum and Ahmedabad.

Central Mental Hospital, Yeravda, Bombay.—This is the chief mental hospital in the Bombay Presidency and is situated in the open country 5 miles from Poona. There are sections for Europeans, Parsis and Indians, the total number of patients accommodated being 415 males and 215 females. The design consists of a large number of separate blocks covering an extensive area and grouped round the central administrative buildings. The activities of the Hospital consist in the general treatment of

all types of mental disease as found in the Presidency, the most important being maniac-depressive insanity, dementia præcox and the toxæmia of *Canabis indica.* Hydro-therapeutic treatment has lately been introduced and is proving highly beneficial. There are facilities for occupational treatment and a special effort is being made to increase the opportunities of recreation for recovering cases.

N. M. Mental Hospital, Thana.

The Acworth Leper Asylum, Matunga, Bombay.—Was founded in the year 1890. It provides accommodation for the segregation of 364 pauper lepers. The Asylum is maintained by joint contributions from Government and the Bombay Municipal Corporation.

A Hindu Temple, a Mahommedan Mosque, two churches, —one Roman Catholic, the other Church of England, a Co-operative Store, a Cricket pitch, a Football ground, a Badminton court, a School for leper children, a Model cinema and a hot-water boiler for bathing may be mentioned among the amenities provided for the inmates. A garden, a sewage farm and a carpenter's shop provide work for those who wish to work and they are paid a small allowance which they use in buying small luxuries from the Co-operative Store conducted by the lepers in the asylum grounds.

Treatment of leprosy on modern principles is employed. All the wards have been provided with the latest sanitary arrangements. The sewage of the asylum is disposed of in the asylum ground by means of a septic tank. Food is cooked and served and clothes washed by healthy servants. Mattresses are disinfected every quarter. The staff have been provided with free quarters in the asylum premises. No case of leprosy has occurred among them in the 37 years that have elapsed since the Asylum was founded.

BURMA.

Rangoon General Hospital.—Was opened for the reception of patients in 1854. The present hospital building was occupied on the 4th April, 1911.

Accommodation is provided in the main building paying wards and subsidiary wards for 540 patients. There is a well equipped out-patient department with special sections for diseases of the eye, venereal diseases and leprosy. A new building has recently been opened for X-ray examinations and electro-therapeutics for the study of morbid anatomy. The laundry is fitted with modern machinery and is in charge of a manager who has been trained in England.

The average number of patients treated during the past three years is as follows:—

Year.	In-patients.	Out-patients.
1924 ..	.. 11,075	80,934
1925 ..	.. 11,578	80,216
1926 ..	.. 11,649	81,882

The Hospital provides for the treatment of all gynæcological cases, surgical cases, general medical cases, children's diseases and diseases of the eye.

The Dufferin Hospital, Rangoon.—The Dufferin Hospital was formerly a Maternity Hospital, managed by the Countess of Dufferin Fund for Supplying Medical Aid to the Women of India. It has now been taken over by the Burma Association for Supplying Medical Aid to the Women of Burma and is managed by a Committee appointed by the Council of that Association. It is being enlarged and rebuilt by funds supplied by the Local Government. The Hospital depends largely upon Government for funds but is supported to some extent by subscriptions from local bodies and the general public. When completed there will be 120 beds for maternity cases and 80 beds for gynæcological cases. The Hospital is a training school for medical students and midwives.

The Rangoon Mental Hospital.—The Mental Hospital serves the whole Province of Burma and the Shan States for the reception and care of all new cases of insanity requiring institutional care and treatment. There is a small subsidiary mental hospital for 130 chronic cases at Minbu in order to relieve

the Rangoon Mental Hospital of a proportion of its chronic cases.

The number of persons under treatment in 1926 was 1,194. Patients are at present treated in Rangoon partly in the old Mental Hospital established in 1871 and partly in the new Mental Hospital now under construction.

The former institution started on a very small scale housing only 100 cases who had been collected in jails where they used to be taken care of when homeless or unmanageable.

The new Mental Hospital is being laid out in five sections enclosed by a wall outside of which are the areas for the staff quarters, grazing of cattle, vegetable garden, etc.

The Mandalay General Hospital.—The present site was purchased in 1889 situated in Fort Dufferin which were demolished. The Hospital was occupied in 1890. In 1895 a Children's ward was constructed and quarters for nurses were added. In 1903 the new Out-patient Department and a Dispensary were added to the Hospital. In 1905 a Maternity Department was added and in 1908 a new Ophthalmic ward was completed. In 1926 the construction of a new Women and Children's block was started and is now nearing completion. A new scheme for the complete reorganisation and reconstruction of the Hospital has been drawn up by a Committee formed for the purpose. This scheme provides for 382 beds comprising the following buildings—three male blocks, an X-ray and Operation Theatre block, an Administration block, an Eye Out-patient Department, Isolation wards, and quarters for the staffs. The average number of out-patients at present being treated is about 31,000 per year, in-patients about 5,000.

Queen Alexandra Children's Hospital, Mandalay.—This is a small children's hospital organised by the Winchester Mission. It consists of 30 beds and is supported entirely by voluntary contributions and is administered by the Winchester Mission, S. P. G. The Hospital was built and opened in August 1921, Government providing a grant of 50,000 rupees as its part of contribution. The average number of out-patients treated per year is about 3,000 and in-patients about 200.

The General Hospital, Bassein, has accommodation for 87 males and 28 females. The daily average out-door attendance is 80 males and 71 females. The average in-door attendance is 66.

The General Hospital, Akyab.—Besides Rangoon, Akyab is one of the few towns in Burma that possesses a modern hospital. It is situated outside the congested areas of the town and is easily accessible from all parts. There are altogether nine blocks of buildings laid out in the form of a U facing west. The average number of patients treated annually is in-door 62 and out-door 150. The total number of beds is 131.

The General Hospital, Moulmein.—This Hospital was opened in 1877. It consists of a long compact single building with a central block and two wings on either side. The building is a wooden two-storeyed structure lying north to south and facing west. The average number of in-patients per year is about 3,000 and out-patients about 18,000.

Leper Asylum, Rangoon.—Is situated on either side of Hanthawaddy Road off Prome Road. To the south of the road is the male section, to the north the female. The Asylum is managed by the Roman Catholic Mission. There is accommodation for 180 patients.

Leper Asylums, Mandalay.—There are two Leper Asylums in Mandalay, one managed by the Catholic Mission and the other by the Protestant Mission to Lepers.

Leper Asylum, Moulmein.—The Asylum is run by the Protestant Mission to Lepers.

CENTRAL PROVINCES.

Mayo Hospital, Nagpur.—This is the principal Hospital of the Province. It has 178 beds and an addition of 40 beds for maternity and gynæcological cases is in view from September next. It provides clinical material for the teaching of students of the Robertson Medical College. It has Honorary Physicians and Surgeons and special department, Dental, Eye, Ear, Nose and Throat, in charge of Honorary Specialists in these subjects

A centre for anti-rabic treatment was opened in 1923. Nursing classes were instituted in 1925 and these will shortly meet the demand of the Province for trained nurses.

Victoria Hospital, Jubbulpore.—The Hospital is centrally situated in about ten acres of ground consisting of three parallel stone and brick buildings, each having an upper storey. The middle block was constructed in the year 1876. Cases including maternity and from all classes are admitted. There are three other blocks of buildings for paying patients and for chronic cases. The block for the latter is of the pavilion type. There is a well equipped operation theatre, X-ray Department, and a Pathological Department where anti-rabic treatment is also carried out. Cataract and Stone cases are the commoner major operation. The Hospital staff consists of an officer of the I. M. S. and five assistants, four nurses, and three midwives. The Hospital has its own electrical installation.

Mental Hospital, Nagpur.—There were two Lunatic Asylums in the Central Provinces up to 1910, one at Nagpur and one at Jubbulpore. In 1910 the Jubbulpore Asylum was amalgamated with the Nagpur Asylum, which is now the only Institution where insane patients are admitted from the Central Provinces and Berar and Central Indian States. There is accommodation for 312 males and 126 female patients including accommodation for 8 paying patients. There is special accommodation for patients suffering from tuberculosis where they can be kept separate from the others. There are two vegetable gardens including a Farm and Dairy and Weaving.

DELHI.

Lady Hardinge Hospital (for Women).—In connection with the Lady Hardinge Medical College for Women, the Hospital, built on the block system, contains 210 free beds, divided between the medical, surgical, gynæcology and midwifery, and eye, nose, throat and ear units with private wards and European rooms and operating theatres attached. The large Out-patients Department contains also X-ray, Electrical and Eye Departments. Twenty-six family or Indian cottage

wards provide accommodation for a patient's relatives to reside with her during her treatment in hospital. Women and children come not only from Delhi but from long distances for treatment. The prevalence in the district of osteomalachia with resultant gross bony deformities means for a number of patients long treatment—dietetic, medical and manipulative, and the performance of a number of Cæsarian sections.

MADRAS.

Government General Hospital, Madras.—The first British Hospital in Madras was founded on November the 10th, 1664, and until 1899, when handed over entirely to the Civil Government, this Hospital treated both Military patients from the Garrison and Civil patients from the town. Amongst the contributors to an earlier hospital built in 1692 was the Governor Elihu Yale who later on founded Yale University in America. The present hospital was built in 1753, plans for its erection having been prepared soon after the Siege of Madras by the French and after the City had suffered severely from a cyclone which wrought much havoc to the existing hospital. The General Hospital has accommodation for 510 patients, European and Indian, in the general wards; and has also 18 private paying wards, primarily intended for Government servants. A scheme has recently been sanctioned for completely remodelling and adding to the present hospital at a cost of Rs. 39½ lakhs. The scheme provides for a complete modern Out-patients Department (to include special facilities for the treatment of Leprosy and Skin Diseases), a new Venereal Department, a Radiological Department and new Operation Theatres.

The General Hospital is the main clinical teaching institution for the Madras Medical College, the 500 students of which pass through the wards of the Hospital and receive appointments as surgical dressers, medical clerks, etc.

Until recent years, the senior staff of the Hospital has been found from amongst the members of the Indian Medical Service whose work has added much to the knowledge of Tropical Diseases. Of more recent workers, Col. Donovan (kala-azar)

and Col. Maitland (filariasis, etc.) were for many years members of the Hospital staff.

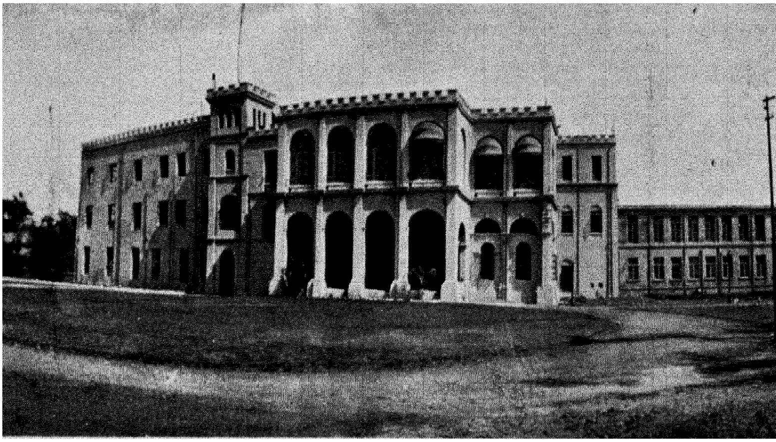
Government Royapuram Hospital, Madras.—Has 350 beds and provides clinical material for the Royapuram Medical School.

Government Hospital for Women and Children, Egmore, Madras.—This is perhaps the largest Obstetrical and Gynæcological centre in the East. On an average about 3,000 women are confined in the Hospital, nearly 40 per cent. of the cases being complicated. In the Gynæcological Department over 2,000 cases are admitted every year and at present there is a provision of 20 beds for treatment of diseases of children. The Hospital is under the management of the superintendent who is also the Director of the Obstetrical and Gynæcological Units. He is assisted by the assistant superintendent, honorary physician, a resident assistant surgeon, 3 other medical officers and 5 house surgeons.

The medical students of the Universities of Madras, Lahore, Lucknow and Andhra, receive their clinical training at this Hospital. The Hospital affords excellent clinical material so that a large number of post-graduates come for training for short periods from all parts of India, Burma, Ceylon, Straits Settlements, Hongkong and Singapore. There is a school attached to the Hospital, the Giffard's School of Obstetrics, where medical students, midwives and post-graduates are given all facilities for training. Recently the University has instituted a Diploma in Gynæcology and Obstetrics the training for which extends to a period of one year. The Hospital affords special facilities for the study of Puerperal Eclampsia and Sepsis, and the ante-natal wards afford facilities for study of the pathological conditions of pregnancy. There is a large Out-patients Department attached to the Hospital. The Hospital has a provision of 250 beds and proposals for increasing the accommodation and build a separate ante-natal block and children's wards are under consideration.

The Government Eye Infirmary, Madras.—The original buildings on the present site were completed in 1886 and consist

PLATE IV.



Haffkine Institute.
View from the front.

Taking venom from a Russell's Viper.

of 3 blocks, an Out-patient Department, a Central Administrative and Operation block and a block on either side containing wards to accommodate 56 beds. In 1911 a new block of wards for cataract cases, an operation theatre and a refraction room were opened by Lady Lawley. In 1920 the Elliot School for teaching Ophthalmology was opened comparing favourably in equipment and design with any school in Europe.

The Hospital has expanded from an Institution capable of dealing with a limited number of cases in Madras to a hospital of 170 beds at which cases from all parts of India are received. The daily number of patients is 220 out of which every variety of eye disease is admitted for treatment in the Hospital. A special impetus was given to the treatment of glaucoma by Lieut.-Col. Elliot, who introduced his technique of sclero-corneal trephining which has received universal recognition.

Mission Hospital, Madras Presidency.—A large part of Medical Mission work in India is concentrated in Madras Presidency which has 51 hospitals and 28 dispensaries. About 600,000 patients are treated annually. Of the hospitals 25 are for women, 23 general, and 3 for men.

Work of special nature is carried on in Vellore Medical School for Women and in the Tuberculosis Sanatorium near Madanapalle, both Union Mission institutions. The Missions manage 12 institutions for lepers. There are about 12 men and 40 women missionary doctors engaged in the work and about 30 missionary nurses. 7 hospitals have training schools for Indian Christian nurses. The great majority of the hospitals are located in rural areas and provide medical relief chiefly to the poor and to women who are reluctant to avail themselves of treatment by men doctors.

Lady Willingdon Leper Settlement, Tirumani, Chingleput.—Founded in 1841 at Royapuram, Madras, the institution was transferred to its present location at Tirumani, three miles out of Chingleput in 1925. Government handed over the management to the U. F. Church of Scotland Mission for a period of five years from 20th July, 1925.

The Settlement is divided into three zones—tainted, neutral and clean. The latter zone has a boarding school for untainted children. The neutral zone has the administrative blocks and the observation blocks. The tainted zone, besides the housing accommodation for lepers, has an excellent hospital, dispensary, and recreation hall.

At present there are seventy-one separate cottages each housing six patients. This together with the Boarding School, the Anglo-Indian Married Quarters, and the Hospital, allows us a total population of about 500. The inmates are mostly of the beggar class with an undue proportion of "burnt out" cases. Government are proposing the erection of a separate place for this type and then the existing place will be converted into a treatment centre. The most up-to-date anti-leprotic treatment is given, based on Hydnocarpus Oil and its derivatives, and the results are very encouraging. An effort is also made to provide suitable and healthful occupation for mind and body—an essential element in all treatment for leprosy.

The Union Mission Tuberculosis Sanatorium at Arogyavaram, near Madanapalle.—This Institution was founded in 1912 and is under the management of 14 missionary societies. In general and special wards it has accommodation for 170 patients who come from all parts of India. The most modern treatment of the West is used here with equally good results, although special attention has to be paid to tropical complications. Research work on tuberculosis in the Tropics is carried out. Doctors and medical students are trained, and courses are given in modern tropical laboratory work. The Sanatorium is maintained by fees from patients (poor patients treated free), by government grant and mission contributions.

PUNJAB.

Mayo Hospital, Lahore.—Associated with the King Edward Memorial Medical College. A hospital was erected and opened in 1871. It had accommodation for 114 patients, Europeans, Anglo-Indians and Indians. This hospital was visited shortly after its opening by Lord Mayo, the Viceroy of

India at that time, who consented to it being named "The Mayo Hospital." In 1890 a separate wing of the hospital was opened for Europeans and Anglo-Indians, the foundation stone being laid by H. R. H. Prince Albert Victor, after whom it was named. In 1902 an Ophthalmic wing with 72 beds was added. In 1905 the Madan Gopal Block of buildings with 28 beds for septic cases was built, thus increasing the in-door accommodation for Indians to 200 beds. With the completion of the King Edward Memorial Scheme the X-ray and Electrical Departments of the Hospital were extended and equipped with modern apparatus. There is a Maternity Hospital of 56 beds. The Hospital affords clinical facilities for the students of the King Edward Memorial Medical College. It has accommodation in all for 400 patients (*see* also King Edward Memorial Medical College, Lahore).

Sir Ganga Ram Free Hospital, Lahore.—This Hospital started in the heart of Lahore City was primarily intended to serve as a Dispensary but in the course of 6 years has developed into a well equipped up-to-date Hospital. There are 40 beds. During 1926, 764 in-patients and 91,335 out-patients. The work of the Hospital is divided into Medical, Surgical, Gynæcological and Eye, Ear and Nose Departments. Arrangements are in progress for Dental and X-ray Departments. A laboratory for Bacteriological and Pathological work is attached. The staff consists of two honorary surgeons, two assistant surgeons, one lady doctor, besides the necessary nursing staff, compounders, etc. The Hospital is one of a number of charitable institutions supported by a Trust endowed by the late Sir Ganga Ram.

Punjab Mental Hospital, Lahore.—Built in 1900 for the accommodation of 450 insane patients. It is the only Institution for the treatment of Mental Diseases in the Punjab. It has been added to from time to time and now rather more than 900 patients are under treatment. They are employed in gardening, weaving, tailoring, etc. The Hospital is self-supporting so far as the clothing of its patients and vegetable supplies are concerned. It is of interest as showing the close connection between Asylums and Jails in older conceptions as the architecture is almost entirely that of a penal institution, but steps are being taken towards

remodelling of the Hospital to bring it into line with modern requirements.

UNITED PROVINCES.

King George's Hospital, Lucknow.—Associated with King George's Medical College and with the Pathological Department of Lucknow University, etc., the Hospital was formally opened by His Excellency the Viceroy in January 1914. The number of beds is 232, and besides the main block there is an Isolation Ward and separate Cottage Wards. The building is in the Indo-Saracenic style to be in keeping with its surroundings and cost Rs. 30 lakhs of which Government of India provided 10 lakhs. Projects for a Maternity and Women's Hospital, as also a Tuberculosis and Ophthalmic Hospital and other extensions are in progress.

Thomason Hospital, Agra.—Associated with the Thomason Medical School, the Hospital was built in 1854. It has Medical and Surgical Wards with 117 beds, the O'Meara Ward for septic cases in the charge of an Emergency Medical Officer with 26 beds, special Operating Theatres and Emergency Out-patients Department, European Wards, Maternity and Gynæcological Wards with special Labour Room, Operating Theatre, Eye Hospital with 75 beds. There are Medical and Surgical and Women and Children's Out-patients Department dealing with 45,000 cases annually. The nursing staff consists of a matron, 7 staff nurses and 20 probationers.

Infectious Diseases Hospitals at Hardwar, Fyzabad, Muttra, Naini Tal and Mussoorie and one under construction at Benares.

Agra Mental Hospital.—This is the principal Institution of this nature in the United Provinces. Besides accommodation for over 750 patients it provides lectures and practical teaching in the care of Mental cases to the students of the three medical schools of the Province as well as to those of the Lady Hardinge Medical College at Delhi. The Hospital was opened in 1869 as a small institution of some 250 beds. Up to 1904 it was a

collateral charge of the civil surgeon, but in that year extensions and alterations were completed, new sections opened out and a whole-time superintendent put in charge. It was not, however, until 1911 that a fully qualified Mental Specialist was appointed superintendent.

The Hospital is situated among well kept grounds some 2½ miles from Agra and as the dividing walls between sections are reduced to a minimum the usual feeling of restraint and confinement attached to such a place is but little felt. Electro-therapy and Endocrine Treatment are in daily use giving most excellent results in certain types of cases. Employment and recreation receive due attention and it is surprising how much of the work is carried on by the patients and how happy and contented they seem to be on the whole.

Up to 1918 the Hospital took Europeans as well as Indian cases, but in 1918 European cases were all transferred to Ranchi and since then the Agra Hospital has been purely for the care and treatment of Indians. Up to July 1927 both criminal and non-criminal cases were treated, but at that time all criminal cases were transferred to Benares which became a Criminal Lunatic Asylum and Agra is now a mental hospital purely for non-criminal cases. In late years a section has been opened for Indian Ladies and one for Indian Gentlemen. The former is regarded by the staff with no little pride but the latter requires enlargement and some alterations before it can be considered satisfactory.

INDIAN STATES.

AJMER STATE.

The Victoria Hospital, Ajmer.—Was opened in March 1927, to replace the old hospital built in 1895. The Hospital was built from money given by certain Ruling Princes and the public of Ajmer-Merwara. The Government of India gave one lakh. It contains 2 up-to-date Operation Theatres, a good Laboratory and excellent Wards. An up-to-date X-ray Room is under construction. It is called the Victoria Hospital after the old hospital

which it replaced. It has accommodation for 87 in-patients and a good out-patient department.

BHARATPUR.

Victoria Hospital, Bharatpur.—The Hospital stands in a picturesque position along the banks of the fort moat and in extensive grounds and well laid garden. The buildings of the Hospital are of handsome design having been planned by the late Sir Swinton Jacob, C.I.E., the famous architect of Jaipur State. The Hospital was opened in 1900. It has accommodation for 100 in-patients. In 1925-26 the number of out-patients treated was 56,664 and of in-patients 836. 1,303 operations were performed.

BIKANIR.

Bhagwan Das Hospital, Bikanir.—Has accommodation for 50 patients. Major operations number about 300 per year. The Hospital is equipped with C. 10 kilowatts X-ray apparatus and an electro-therapeutic department. There is a Laboratory where intravenous injections are given and where there are facilities for blood and urine examination, etc. Out-patients in 1926 numbered 37,349 and in-patients 1,052.

JAIPUR.

Mayo Hospital, Jaipur.—Built to commemorate the visit of Lord Mayo to Jaipur in 1869. Has accommodation for 220 patients. It has Surgical, Medical, Eye and Female Out-patients and Surgical, Medical and Female Wards. The Curzon Wyllie Wards built in 1911 are cottage hospitals to accommodate middle class male patients (5 quarters), the Chappar wards include general as well as cottage wards for 26 families, the Lady Hardinge built in 1922 is a double storey building with 9 female quarters. Old Family wards for 7 families and there are Leprosy and Tubercular wards for 20 patients (10 each). There is an Operating Room, X-ray Department, Clinical and Chemical Laboratory and Medical Store, etc. The number of in-patients in 1926 was 4,888 and out-patients 54,074. Major operations numbered 1,605 and minor operations 2,449.

JODHPUR STATE.

The Hewson Hospital, Jodhpur.—Took the place of a Dispensary opened in 1853. Dates from 1888 but has been considerably added to since then. A New Wing and an Operation Room were completed in 1900. Three double storey blocks have been added from time to time and the enclosure has been laid out as a garden and pleasure ground. The Hospital is named after Mr. Hewson, I.C.S., who was for some time guardian to His Highness the Maharaja. The Hospital has accommodation for 80 in-patients and has an out-patient department. Recent additions are a Pathological and Bacteriological Laboratory and a first class X-ray instalment. Out-patients number about 47,500 and in-patients 1,560. The number of operations is about 2,800 in the year.

UDAIPUR.

The Lansdowne Hospital, Udaipur.—Is situated inside the city near the Hathipol. Was built by Mr. Campbell-Thomson and was opened in 1894. It is a two storey building with a quadrangle inside and accommodation for 60 beds. There is in addition 3 detached wards for Police prisoners and Bhils. In 1926 out-patients numbered 38,079 and in-patients 962. Major operations numbered 236. Two assistant surgeons and two sub-assistant surgeons are attached to the Hospital.

2. MEDICAL COLLEGES AND SCHOOLS.

Of the Indian Universities 6, i.e., Calcutta, Madras, Bombay, Punjab, Patna and Lucknow, confer medical degrees through their affiliated *Medical College*. Delhi also confers medical degrees for Women through the *Lady Hardinge Medical College*. There are also *Medical Schools* giving licenses entitling to practice Medicine and Surgery. There are 23 such schools distributed as follows, Bengal 5, Madras 7, Bombay 3, United Provinces 2, Punjab 2, Burma 1, Bihar and Orissa 2, and Assam 1. Four of the above schools are for women students only, viz., Missionary Medical School for Women, Vellore, Lady Willingdon Medical School for Women, Madras, Agra Women's Medical School and the

Ludhiana Medical School and College for Women. Medical Colleges or Schools that may be specially mentioned are:

ASSAM.

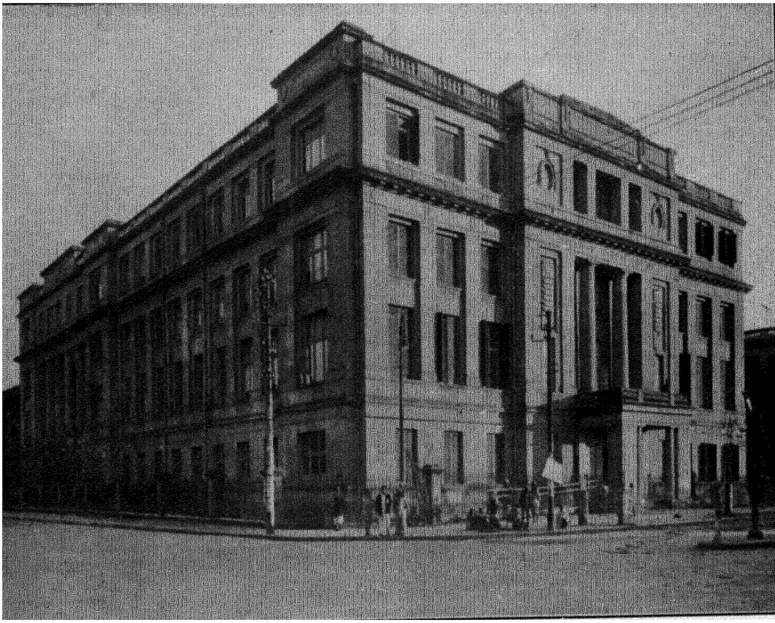
Berry-White Medical School, Assam.—The Berry-White Medical School is located at Dibrugarh, Lakhimpur, Assam. It owes its existence to the foresight and generosity of Brigade-Surgeon John Berry-White, one of the early medical practitioners connected with the Tea Industry in Assam. By his Will he bequeathed to Government a sum of Rs. 50,000 for this purpose. This sum was supplemented by Government, and the School was opened in 1900. The School is the only medical school in Assam, and undertakes the training of suitable inhabitants of the Province for the diploma of L.M.P. under the Assam Medical Act; those qualified belonging to the sub-assistant surgeon class. As this class of practitioner is employed very largely on tea gardens under European medical supervision, the School supplies a very important class for the medical needs of the Tea Industry.

The School has accommodation for 200 students and also undertakes the training of compounder students, who now number 50. The course of the former occupies four years. The staff consists of a superintendent and specially selected instructors from the Government Senior and Junior Services. The buildings consist of lecture rooms, laboratories, dissecting room, students' hostels, etc., and the School is affiliated with the Dibrugarh Hospital of 112 beds.

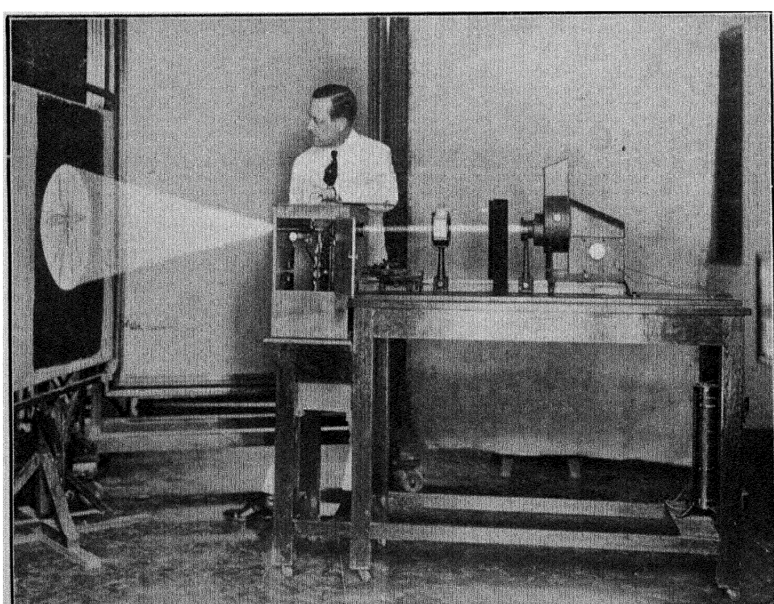
BENGAL.

Calcutta Medical College.—One of the oldest and most important medical colleges in India, the number of students being over one thousand.

A Medical School was opened in Calcutta in 1824 to train native doctors for various establishments with the Civil and Military branches of the Service. The students were distributed for clinical teaching to the General Hospital, King's Hospital and the Hon. Company's Dispensaries and Native Hospital. In 1835



The School of Tropical Medicine, Calcutta.



the Sanscrit College Medical Class, the Medical Class of the Madrassa, and the Native Medical Institution were abolished and a new college, the Calcutta Medical College, formed. The books and apparatus of the abolished institutions were made over to the new School and housing given for this in the buildings formerly occupied by the Petty Court Jail. Anatomical preparations were obtained from England and a curator appointed to organise a museum. The College was the first in the world to teach the preliminary Sciences and give Clinical Training under the same roof. Sir Leonard Rogers was for long Professor of Pathology in the College, and the Pathological Museum owes much to his unremitting toil to do justice to the material available. Associated with the College is the Calcutta School of Tropical Medicine. For Clinical Teaching the School has the associated Medical College Hospital, Eden Hospital for women and other facilities.

Carmichael Medical College, Belgachia.—This College, the first recognised non-official Medical College in India, came into existence in 1916. It was affiliated to the University of Calcutta in the Preliminary Scientific M.B. Standard in April 1916, and for the Final M.B. Examination in April 1922. The institution that developed into the College was at the time of affiliation known as the Calcutta Medical School and College of Physicians and Surgeons of Bengal. It had its origin in the year 1886 when it was decided to start the first private medical school to supplement the efforts of Government under the designation of the Calcutta School of Medicine (later Calcutta Medical School). The bulk of the present site was bought in 1896 and the School was removed to Belgachia in 1903. For clinical instruction the students originally attended the Mayo Hospital. The Albert Victor Hospital (one storey building) with 40 beds was formally opened in 1902. The upper storey was built and new wards were opened in 1909, the total number of beds being then increased to 100. The College of Physicians and Surgeons of Bengal, another private institution started in 1895 aiming at medical education of the collegiate standard, was amalgamated with the School in 1903 the name of the combined institution being then changed accordingly.

During thirty years hundreds of trained medical men passed out who are doing useful work under Government, municipalities, in the various industries (Jute, Tea, Shipping, etc.), or as country practitioners. This was rendered possible by the voluntary, ungrudging and unpaid work in the School and in the Hospital by the independent medical profession. In 1911, before the introduction of the Medical Registration Bill, the Government asked the private medical institutions in Calcutta to unite and form one good and efficient teaching institution with a view to helping its recognition by the University or Bengal Council of Medical Registration. Ultimately a scheme was framed and affiliation to the University of Calcutta was obtained in April 1916. The College was formally opened as the Belgachia Medical College, by His Excellency Lord Carmichael, Governor of Bengal, on 5th July, 1916. The College was named after Lord Carmichael in 1919 in appreciation of his services in connection with its institution.

The College curricula are in accordance with the M.B. Examination rules of the Calcutta University. The number of students in 1924 was 694 and application 944 as against 1,050 in the previous year.

The government of the College is now vested in a Council consisting of 11 members, of whom 3 are nominated by Government and 1 by the Corporation of Calcutta. The President is Sir Nilratan Sircar, *Kt.*, M.A., M.D., D.C.L., LL.D.

BIHAR AND ORISSA.

The Prince of Wales Medical College, Patna.—Has evolved out of the Temple Medical School of Patna. This was opened by Sir William Temple in 1874 and named after him. The formation of a medical college for the Province having come under discussion, the Hon'ble Maharajadhiraj of Darbhanga came forward with a donation of Rs. 5 lakhs to be spent in establishing a medical school at Darbhanga and converting the Temple Medical School into a first grade medical college. A fund was started with this object, the Maharajadhiraj contribution acting as a nucleus.

The College buildings consist of separate blocks standing side by side along the banks of the Ganges. The administrative block recently built contains the office, library and spacious examination hall. Anatomy has a separate block. Physiology and Pathology at present share a common building as do Pharmacology, Biology and Organic Chemistry. There is a large and well built Hostel for students in the compound.

The Hospital has about 450 beds with separate block for Eye, Ear, Nose and Throat cases. A large Hospital for women is nearly completed. A new block, the European Cottage Hospital with six beds has recently been added. There is a well-equipped X-ray installation. There are residential quarters for the house and nursing staff in the compound and for the professorial staff on the river side.

The College teaches up to the final M.B., B.S. and is affiliated to the Patna University.

BOMBAY.

Grant Medical College, Bombay.—This College is the Government college recognised by the University of Bombay for all medical examinations. It was established in 1845. Formerly it gave a Diploma G.G.M.C. (Graduate Grant Medical College), but upon the establishment of the University of Bombay in 1860 it ceased to grant diplomas and became affiliated to the University. The College is under a Dean who is subordinate to the Surgeon-General with the Government of Bombay.

The College consists of a number of detached buildings spread over an extensive compound and possesses well-equipped and up-to-date laboratories. The staff consists of 19 professors, 3 associate professors, 3 assistant professors, 19 tutors and 9 demonstrators. For clinical instruction the following hospitals are associated with the College, J. J. Hospital, G. T. Hospital, Bai Motlibai and Petit Hospitals, Sir C. J. Ophthalmic Hospital, Cama Hospital and N. J. Wadia Maternity Hospital. The total number of beds available for clinical teaching is 536.

The total number of regular students attending the College is 518, of which 60 are women students. Students are admitted

one a year in June and the number of admissions is restricted to 120. A few scholarships are given to deserving undergraduates from College endowment funds. 11 fellowships at Rs. 50 a month are available to fresh graduates to enable them to proceed to higher degrees.

Seth Gordhandas Sunderdas Medical College, Bombay.—The need for another Medical College in Bombay being felt, the Corporation of Bombay accepted the offer of the Trustees of the late Seth Gordhandas Sunderdas of Rs. 14,50,000 to endow such a College. The College, which was opened on 4th June, 1925, is in connection with the King Edward VII Memorial Hospital and is a handsome three storey building designed in an E shape with possibilities of future extension. There is a Hostel attached to the College with accommodation for about 100 students. The College cost about 18 lakhs to build and 3½ lakhs to furnish and equip.

Byramjee Jeejeebhoy Medical School, Poona.—Is named after Mr. Byramji Jeejeebhoy who donated Rs. 10,000 to its inception in 1878. It is affiliated to the College of Physicians and Surgeons of Bombay. Successful candidates at the Final Examination are granted its licence which is registrable. Its object is to train the class of subordinate medical officers, formerly called hospital assistants. Some of the licentiates are taken into the Subordinate Medical Service of the Bombay Presidency as vacancies occur, some engage in private practice, while others obtain suitable appointments in India and in the Crown Colonies. Up-to-date laboratories are being constructed and equipped. The number of students is about 250 of which about 50 are women students.

Byramji Jeejeebhoy Medical School, Ahmedabad.—Was opened in 1879. Like its sister institution at Poona, it takes its name from Byramji Jeejeebhoy, C.S.I., who generously contributed Rs. 20,000 towards its endowment fund. Students receive instruction in the curriculum laid down for the diploma of L.C.P. & S. (Bom.). Clinical instruction is given in the wards of the Civil Hospital, in the compound of which the School is situated. The number of students is approximately 150. A

number of scholarships are open to students. There is a Hostel accommodating 82 students. Additional buildings have been recently completed at a cost of Rs. 1,30,932 and the equipment for the law laboratories is in progress.

Medical School, Hyderabad, Sind.—The School was started in 1881 by public subscription aided by Government. It prepares students for the L.C.P. & S. Bombay. There are 62 students at present. The Hospital was rebuilt in 1906. It is mainly surgical and is chiefly noted for the number of operations for *stone-in-the-bladder*. In the past 20 years there have been 9,401 litholapaxies. Last year there were 474 litholapaxies and 29 other operations for stone (18 suprapubic lithotomy, 4 perineal and 7 cystotomy). The majority of the litholapaxies are done as outpatients, the cases being kept for 24 hours at least under observation in a " Hostel " and being seen again next day.

College of Physicians and Surgeons, Bombay.

CENTRAL PROVINCES.

Robertson Medical School, Nagpur.—About 70 years ago there was a medical school in Nagpur, training civil and military hospital assistants. It was however closed, and students from C. P. were sent to Patna Medical School for training. The present school was established by Sir Benjamin Robertson in 1914. It has 2 lecture halls, a physical and chemical laboratory, a physiological and pathological laboratory: X-ray and electric treatment room, a pathological, anatomical and materia medica museum. A library containing about 2,000 volumes, a dissection hall and attached buildings. It has attached to it 2 good hostels, which can accommodate over 150 boarders, with attached bath rooms and dining halls, and large grounds for tennis, hockey, football, volley ball, etc. A medical troop of boy scouts, under a scout master was started in 1926.

The school started with 25 students in 1914, at present there are over 200 students, male and female. The number of admissions every year is limited to 50—60, owing to want of accommodation in lecture hall laboratories which it is proposed to

enlarge by adding top stories. Clinical material for teaching purposes is drawn from the Mayo Hospital situated in the same grounds, with a total indoor accommodation for 73 medical and 99 surgical beds. The outdoor department has a daily attendance of 187·02, consists of medical, surgical, eye, ear, nose, throat, women and children's dental, anti-rabic and venereal departments. There is a good operation theatre. All buildings have electricity installed.

DELHI.

The Lady Hardinge Medical College, Delhi.—As a College entirely staffed by women training students (women only) for a University degree in Medicine, this Institution holds a unique position.

The College is affiliated to the Punjab University and provides a 7 years' course of study in preparation for the F.Sc. Examination (medical group) and M.B., B.S. degrees of that University. The students up to 115 in number, drawn from all parts of the Indian Empire, are resident in five hostels arranged as much as possible according to religions:—i.e., Mahommedan, Hindu Vegetarian, Hindu Non-Vegetarian, Sikh, and Christian. Discipline in the hostels and the welfare of the students are supervised by a warden with the assistance of student-prefects elected by themselves. Various game, social, and dramatic clubs are organised and managed by student committees and keen interest and competition is displayed in the annual matches between the "Years" for the holding of the games' cups.

On a site of 55 acres "the Hardinge" includes Administration Block, College, Hospital, Students' Hostels, Assistant Staff Hostel, Sisters' and Nurses' Hostel, Senior Staff Bugalows, Servants' Quarters, Workshops, etc.; with tennis and badminton courts, hockey and basket ball grounds and promenade gardens.

The College consists of the usual laboratories and lecture rooms for Science and preliminary medical subjects, with their accompanying museums; the Pathology laboratories, museum, culture rooms and post-mortem theatre; and a large library. The Hospital is referred to elsewhere.

The eight senior medical staff and professors are supplied from the Women's Medical Service, India—two of whom are also principal and vice-principal. Science Lecturers hold British degrees, and the assistants and house surgeons are Indian graduates chiefly former "Hardinge" students.

The Nurses Training School supervised by a matron and six sisters (all British-trained) with the help of Indian Staff Nurses, gives a four years' training in Nursing and Midwifery for Indian nurses—forty-seven girls being in training at this time.

A Compounders School with 4 pupils is staffed by a British-trained Pharmacist with 2 Indian compounders as assistants; these are also responsible for the dispensing for in- and out-patients.

Training is given for 7 nurse dais; in addition three—who have obtained their diplomas—are retained on the staff to attend midwifery cases in the district.

MADRAS.

Madras Medical College.—Was originally established as a Medical School in 1835 by the Right Hon'ble Sir Frederick Adam, K.C.B., under the terms of G.O. No. 7, dated 13th February, 1835. The classes assembled originally for instruction in rooms adjoining the quarters of the Surgeon of the General Hospital. The accommodation, however, was insufficient for the purpose, and as the arrangements were otherwise inconvenient, the Government of India, on the representation of His Excellency the Governor, were induced to sanction the erection of a separate building. The Medical School was accordingly built and opened for work in July 1836. In 1851 the Medical School became a College and was affiliated to the University of Madras in 1877. Alterations and important additions were from time to time undertaken so that it is now a well-equipped institution. Up-to-date Physiological Hygiene and Bacteriological laboratories were opened in 1911. A Pathological Museum and Library are also attached. A new room for the Biology and Physics classes was added in 1917. Bio-chemistry is taught in a separate temporary laboratory. Whole time teachers in Bacteriology, Venereal Diseases, Diseases of Ear,

Nose and Throat, Radiology and Infectious Diseases are now on the staff. Pharmacology will soon be introduced. A new set of buildings to accommodate the Pathological Institute and the Biochemistry laboratory are being arranged for. The College, which was originally an institution for supplying the army with assistant surgeons and hospital assistants, now also undertakes the training of students for the L.M.S., M.B., B.S. and B.Sc. degrees of the University of Madras and for the Chemists, Druggists, Sanitary Inspectors and Health Officers' certificates. A course of six months in Dentistry for Civil Apothecaries and senior grade sub-assistant surgeons not exceeding 5 at a time was started in 1920.

Rayapuram Medical School, Madras.—The Government Rayapuram Medical School accommodating over 500 students is situated in George Town, Madras, and a senior I.M.S. officer is its superintendent with a staff of 13 lecturers and 11 assistant lecturers. Theoretical and practical courses extending to 4 years in Chemistry, Anatomy, Physiology, Materia Medica, Pathology, Medicine, Mental Diseases, Surgery, Midwifery and Ophthalmology and theoretical courses in Hygiene and Medical Jurisprudence are given to prepare students for the L.M.P. Diploma of the Madras Government. They undergo Clinical training in Medicine, Surgery and Ophthalmology at the Government Rayapuram Hospital with 350 beds and Midwifery at the Ramaswamy Lying-in Hospital of 50 beds. The School Library has 1,357 volumes besides 16 journals. Adjoining the School, there is a hostel for 292 students with a spacious play-ground.

Vizagapatam Medical College.—In response to the requests of the people of the Telugu Districts, the Government of Madras early in 1923 decided to establish a medical college at Vizagapatam. The College was opened on July 1923, in the old Hospital buildings. Since then two new blocks of buildings have been erected, complete with all modern appliances and up-to-date in all respects, with fully equipped laboratories and anatomical rooms, etc. There is also a large modern Hospital with modern appliances with accommodation for 250 beds. A new Maternity Unit of 40 beds is nearing completion and extension of the

Ophthalmic Unit to 80 beds is being carried out. There is a large staff of professors and teachers.

The number of students is 160, preference being given to students from the Telugu Districts. The College forms the Medical Unit of the Andhra University and it is expected that the course and degrees will be recognised by the General Medical Council of Great Britain this year.

PUNJAB.

The King Edward Medical College, Lahore.—The necessity for a medical school for the Punjab was first recognised by Sir John Lawrence in 1857, but owing to the Indian Mutiny and its attendant financial difficulties the construction of a College was not begun until 1860 when Sir Robert Montgomery was Lieutenant-Governor of the Province. The original Medical College was located in the old Artillery Hospital in Anarkali, the site of which is now occupied by the Government College and its hospital was first established in the stables of Raja Suchet Singh's house in the Tibbi Bazar, now the site of a Police Thana and Munsiff's Court. In 1864 the Institution was moved to a site between the railway and Nisbet Road, and in 1883 it was further moved to the site of the Mayo Hospital, the present Out-patient Department of the Mayo Hospital being all that remains of the College as it then was. In 1893 the present Anatomical Block was built and soon after other departments of the College began to expand and there were built blocks for Pathology and Bacteriology, etc. In 1910 on the death of King Edward VII it was decided to perpetuate his memory in the Punjab by a King Edward Memorial in the form of a new King Edward Medical College and enlargements and improvements of the existing Mayo and Albert Victor Hospitals. The people of the Punjab and Punjab Native States subscribed 17 lakhs and an additional 10 lakhs were given by Government of India. The Punjab Government contributed a further 5½ lakhs and incurred expenditure connected with removal of the Veterinary College with a view to increased site accommodation for the School. In all Rs. 41 lakhs or about £300,000 were expended in connection with the scheme.

The present buildings were opened by Lord Hardinge, then Viceroy of India, in 1915. They consist of a main block, the "Patiala Block" which contains the Administrative Offices, Lecture Theatres for senior students and a spacious Library and Examination Hall; a Research Block, "The Bahawalpur Block" which contains the Pathology Department on the ground floor and the Physiology and Hygiene Departments on the first floor all of which are equipped in an up-to-date and complete manner; the Materia Medica Block or "Kapurthala Block" an old building but now thoroughly re-adapted and consisting of Lecture Theatre, Museum, Practical Class Room and Experimental Pharmacology Room; the Anatomy Block, "Faridkot Block" a large and handsome building with a spacious Dissecting Room, Lecture Theatre, Demonstration Rooms and a large Museum, with special cold storage block and separate Pathological and Judicial Post-mortem Theatres attached. Besides these there is a Students' Hostel, a large building with accommodation for 112 students, animal houses, gas plant and quarters for servants. These buildings comprise the College portion of the King Edward Memorial.

In the Mayo Hospital are two Clinical Lecture Theatres, a large Clinical Pathology Laboratory, three Clinical Sight Testing Rooms, a large Ophthalmoscopic Room, Students' Duty Room and a large efficiently equipped X-ray and Electrical Department. The various out-patients departments, hospital wards and side rooms and operating theatres have also all been designed with thoughts for the students as well as for the patients. There is a Venereal Department and a Maternity Hospital of 56 beds in course of construction and expected to be ready next year. The library associated with the College contains 7,090 books. In addition to the one already mentioned there is another Hostel which provides accommodation for 136 students, or a total of 248 in both hostels.

In 1904 the College was affiliated to the Punjab University which had been established in 1882. From its commencement in 1860 to 1869 the College granted its own Diplomas to practice Medicine and Surgery. From 1869 to 1911, the Punjab University College and its successor, the Punjab University, issued the

PLATE VI.

Kasauli and the Central Research Institute. (right).

Diploma of L.M.S. and the M.B. Degree, but these have been replaced since then by the present M.B., B.S. Degrees. In 1920 the Sub-Assistant Surgeon Class was moved to Amritsar to make room for men wishing to take the M.B., B.S. Degrees. Special post-graduate classes are held every year for assistant surgeons and sub-assistant surgeons.

The annual expenditure on the College for the year ending 31st March, 1927, was Rs. 5,50,349 and that on the Hospital for the year ending 31st December, 1926, was Rs. 5,91,743. The income to the College on account of tuition fees, etc., for the year ending 31st March, 1927, was Rs. 77,247.

There are at present 441 medical students attending the classes. There is a teaching staff of 13 professors and a large number of assistants. For clinical instruction there is the Mayo Hospital with accommodation for 400 patients.

Medical School, Amritsar (Punjab).—The School was separated from the King Edward Medical College, Lahore, and transferred to Amritsar, the next biggest town in the Province, in 1920. It is at present accommodated in temporary buildings. Permanent buildings are under construction and will be ready for occupation by the end of the next year. The staff consists of one principal, nine lecturers and eleven demonstrators. Eighty-five candidates are selected for admission out of three to four applicants each year. The minimum qualification required for admission is matriculation of the Punjab University.

The curriculum extends over full four calendar years and provides instruction in Chemistry, Physics, Anatomy, Physiology, Materia Medica, Pathology, Hygiene, Jurisprudence, Medicine, Surgery and Diseases of Eye, Ear, Nose and Throat and Midwifery.

Two and a half years are devoted to clinical teaching for which nearly 250 beds are available in the Jubilee Hospital, the Eye Department of which enjoys a wide reputation for Smith's Intracapsular Operation, which attracts a certain number of visitors chiefly from across the Atlantic. There have been as many as 282 in-patients on a day in this Department during the

Cataract Operation Season and 1,669 lenses were enucleated during 1926.

Another important feature of the School is that it is the chief centre in India for training candidates for the Sub-Assistant Surgeon branch of the Indian Medical Department of the Indian Army. The number of Military Medical Pupils is about one-fourth of the total on the rolls.

The qualifying examination is for the Diploma of Licentiate of the State Medical Faculty (Punjab) which is registrable throughout India. These licentiates are eminently fitted for providing cheap ordinary medical aid to the poor masses.

An excellent Hostel, with extensive play-grounds, providing accommodation for 320 students is attached to the School.

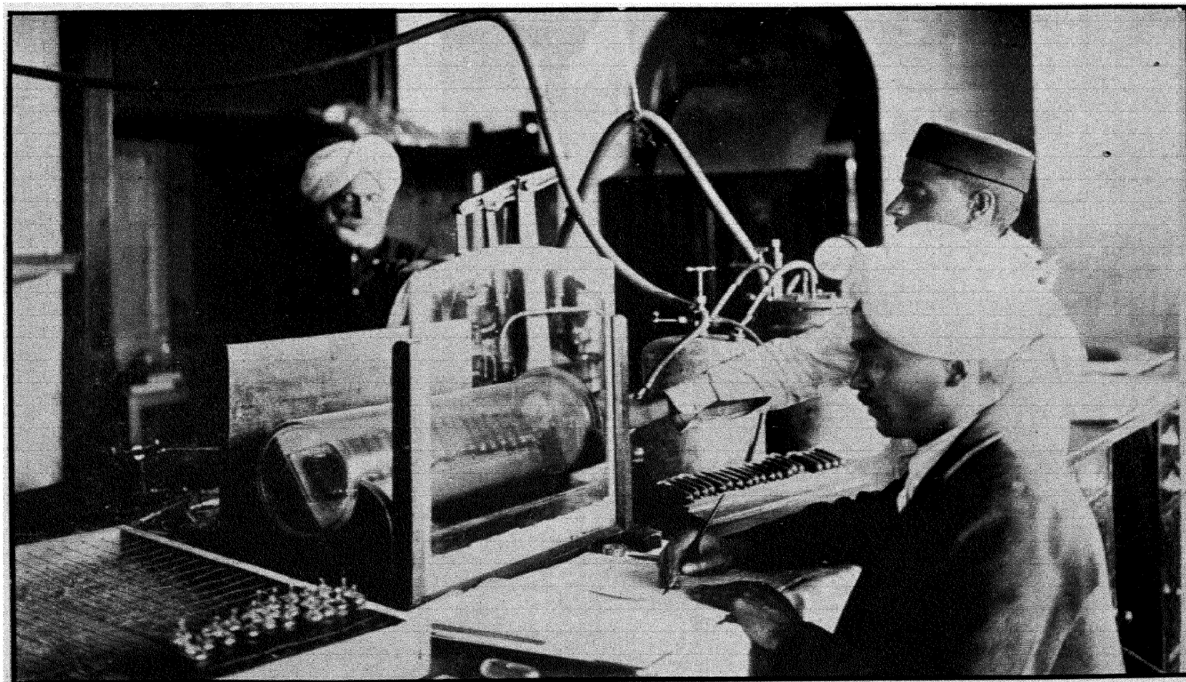
Women's Christian Medical College and Punjab Medical School for Women, Ludhiana.—This was the first medical school opened for women in India. It was founded in 1894 by the present principal, Dr. Edith Brown; its object being to train Indian women as medical missionaries. It was affiliated to the Lahore Medical School. In 1913, at the request of the Punjab Government, its doors were opened to receive non-Christian students, and it became the Medical Training School for all women students of the Punjab.

Up to the present time 174 women have received registrable qualifications, 4 having done 26 years' faithful service, and 5 having won the Kaiser-i-Hind Medal. At present there are under training 83 medical students, 51 nurses, 20 compounders and 48 midwives.

The present senior staff consists of 8 doctors, 1 science mistress and 1 pharmacist, all with Home Degrees, 7 hospital sisters, a secretary and evangelist. The junior staff consist of 7 doctors with Indian diplomas, 8 staff nurses, etc.

The Governing Body (consisting of missionaries belonging to various Missionary Societies) is in India, and a Representative of Government is on the Executive Committee. The annual expenditure is about Rs. 7,75,000 of which over Rs. 80,000 is contributed by the Punjab Government; over Rs. 40,000 is received in professional fees and college fees and scholarships. The

PLATE VII.



Testing filled ampoules for leakage in vacuumised container. (C. R. I.).

balance is received as subscriptions and donations, mostly from the British Empire.

The Hospital has 200 beds for women and children of which 25 are reserved for maternity cases. It is officered entirely by women. The number of in-patients last year was 2,455 and of out-patients 92,595 (43,925 new, 48,670 old). The number of abdominal sections was 200. Maternity work is carried out in the city and villages, last year 553 cases being attended. Post-Natal, Ante-Natal and Child Welfare Work has been begun. The graduates work in all parts of India, Burma and Assam.

UNITED PROVINCES.

Thomason Medical School, Agra.—In association with the Thomason Hospital, a School for medical tuition has existed from shortly after the building of the Hospital in 1854. In 1905—12 the buildings of the School were greatly extended and the number of students raised to 300. The buildings now include a large Dissecting Hall, an Anatomical Theatre to seat 250 students, a Pathological Laboratory, Physiological and Historical Class Rooms, an X-ray Room and a Hostel to accommodate 180 students. The staff consists of a principal (an I.M.S. officer) who is also superintendent of and physician to the Hospital, the civil surgeon who is surgeon to the Hospital and lectures on surgery, etc., and 18 lecturers and assistant lecturers in addition to the 8 house physicians and house surgeons of the Hospital.

The School from 1926 grants the Licentiate of the State Medical Faculty and the power to grant the membership is also under the consideration of Government. The number of students is about 300 of whom about one-third are qualifying for Military employ.

Women's Medical School, Agra.—This Institution began with a class for women students started at the Medical School attached to the Thomason Hospital, Agra, by Dr. Hillson, Civil Surgeon of Agra in 1883. Men and women attended the same lectures. No clinical instruction or experience in midwifery was

provided for women students. After a short time a verandah in the out-door department was curtained off, there women were seen and women students taught both diagnosis and practical dispensing. The course of instruction lasted three years only. In 1886 they were given clinical instruction in the women's ward of the Thomason Hospital and in the dispensary by two medical women.

The first buildings of the Lady Lyall Hospital were completed in 1889 and a Dissection Room for the women students was opened at the same time. The foundation stone of the Maternity Hospital was laid in 1888 and the Hospital which at that time consisted only of private wards and labour room, was opened in 1890. The course of study was lengthened to four years. By this time it was realised that mixed class of men and women were not satisfactory and from 1890 the classes were nearly all separate, though most of the lectures were given by the lecturers of the Men's School.

The Hostel for students was opened in 1908 and the general maternity and gynæcological wards with the up-to-date operation theatre in 1916. The School and Hospitals continued to be administered by the Civil Surgeon of Agra, till 1917, in that year the first woman principal was appointed, though lecturers were still mostly from the Men's School and the students had to go into the men's compound for most of their lectures and classes. In 1923 the ambition of many years was realised, a full staff of women lecturers was appointed, and the school was completely separated from the Men's School.

The wards and out-patient department of the two Hospitals provide ample clinical material. Maternity cases are over 600 a year, including last year 61 cases of Cæsarean section, mostly for osteomalacia; 80 other cases of abdominal section were also carried out in the hospitals during the year. Students at present in the school number 16 Hindus, 3 Mahommedans, 6 Sikhs, 46 Christians and 4 others.

The nursing in the Hospital is done by trained nurses with pupils under them. The training is for three years, 6 months of which are spent in the male wards of the Thomason Hospital.

Nurses who wish to take midwifery also spend $3\frac{1}{2}$ years in training. Pupil midwives are also trained in the Maternity Hospital.

3. MEDICAL RESEARCH INSTITUTES, PASTEUR AND VACCINE INSTITUTES AND PUBLIC HEALTH LABORATORIES.

Of such Institutions there are a number in India of which may be mentioned

GOVERNMENT OF INDIA.

Central Research Institute, Kasauli.—The C. R. I. was opened in 1906 as the Central Laboratory of the Scheme for a Bacteriological Department for India initiated by Col. Leslie, Sanitary Commissioner with the Government of India. It functions as the Bacteriological Laboratory of the Central Government.

The Institute is situated at Kasauli about 10 miles from Kalka, the terminus of the main line of the East Indian Railway, and within 3 hours' motor ride of Simla. It is on a prominent site about 6,000 feet above sea-level directly overlooking the plains. Though sometimes spoken of as a hill top laboratory in reality its situation is eminently suitable to the work it is most concerned with. As a laboratory for basic researches and a centre for work in the field throughout India it has a great asset in a climate in which work can be carried out at full pressure all the year round. Its record of work cannot be beaten by that of any other medical research institute in India. Institute buildings are of a rather miscellaneous character having been extended and added to constantly as requirements demanded, but the question of a new Institute has been under consideration for some time. The staff consists of a Director and three Assistant Directors with a subordinate staff of about 112. The actual number of research-officers engaged is usually, however, considerably greater owing to men being attached or associated with the Institute in various ways.

The Institute especially functions as a *Centre*. It has always been largely concerned directly or indirectly with research

enquiries carried out in various parts of India, and with India's medical research problems as a whole. In addition to enquiries directly staffed and worked by the Institute are many more in which the Institute is indirectly concerned, either from initiating the enquiry or by reason of such enquiries being directed by men who are to be regarded as C. R. I. men and who carry the traditions and methods of the C. R. I. with them. Since the creation of the Indian Research Fund Association the C. R. I. has been very closely connected with the working of this body and acts to a large extent as its chief laboratory.

Besides a centre for enquiries the Institute holds a special position in regard to *basic research.* This has been possible owing to men of especially high technical attainments having usually been on the staff. Among workers at various times at the C. R. I. may be mentioned Semple, Harvey, Greig, Christophers, Cragg, Brown, Iyengar, Sinton, Shortt, Barraud, Covell.

Through its *Serum and Vaccine Section* the Institute manufactures prophylactic vaccines (other than plague vaccine which is entirely prepared at the Haffkine Institute) for the whole of India, Military and Civil, the amounts manufactured by other laboratories being negligible in proportion. Owing to the large scale of production stocks can be maintained to meet indents for almost any quantity at a moment's notice. The production of prophylactic vaccines on a large scale was commenced during the war. Demand for military and also civil purposes first for TAB (Typhoid, para A and para B), then for Influenza and latterly for Cholera has kept the quantity made ever since at or greater than it was during the war. In 1926-27 the quantities issued were Cholera 743,779 c.c., TAB 325,644 c.c., Influenza 42,141 c.c., curative vaccines 13,275 c.c. The medium used is prepared from Casein (produced for trade purposes in India) digested by locally prepared pancreatic extract and preliminarily filtered and dried China Grass. Capsules are filled by the Maynard Apparatus and other vacuum devices in case of small tubes. Besides the issue of prophylactic vaccines the Section also issues Antivenin or immunised serum against Cobra and Daboia venom, these being the two common fatal snakes of India. In 1926-27

PLATE VIII.

The Pasteur Institute of Southern India, Coonoor.

106,240 c.c. of this serum were issued. The Section also deals with preparation of stock and special autogenous vaccines, the preparation and issue of high titre sera and the carrying out of serological tests. It also undertakes researches in questions relating to immunity, vaccines and sera, etc., in which connection may be mentioned the researches of Harvey, Brown, Iyengar and others.

The Malaria Section of the C. R. I. has recently been formed into the *Central Malaria Organisation for India* with an increase of staff to enable it to act as a nucleus of systematic advance in the study and prevention of malaria in India. It has now a separate Director who is, however, under the general direction of the Director of the Institute. The Central Organisation consists of the original *Central Malaria Bureau*, with new buildings in process of erection, a newly purchased building which is being fitted up as an experimental station in malaria, the *Ross Experimental Malaria Station, Karnal*, and a staff consisting of a Director, Assistant Director, 2 special Malaria Research Officers, an Entomologist and it is hoped shortly a Malaria Engineer. In connection with the Bureau are very complete collections of Indian Anopheline and Culicine mosquitoes, collections of freshwater fish, etc., a useful reference library on malaria and material of various kinds connected with malaria work in India. The Organisation (formerly the Bureau) holds an annual *Malaria Class* for instruction in practical malaria, in which both laboratory and field methods are taught. It also publishes bulletins and other publications of an informative or scientific character. It has published a Malaria Map of India and catalogues, synoptic tables, information on larvacides, larva eating fish, infectivity of species of anopheles, etc. It carries out free examination of all material sent by those requiring identification of specimens. As an organisation it will initiate and carry out, or assist in, enquiries on malaria, wherever and whenever such seem desirable and can be arranged for. Surveys of this kind have recently been completed or are still being carried out in the Andamans, Sind, Coorg, and Delhi and other surveys are under projection.

The Entomological Section under the late Major F. W. Cragg, I.M.S., carried out very valuable basic and epidemiological work on insect borne diseases, etc. It is at present awaiting a successor worthy to carry on the work of this well-known authority whose death from Typhus when investigating this disease in India is deeply regretted by all his colleagues.

Among various miscellaneous functions the main Institute carries out a certain amount of routine pathological diagnosis work. It has a fine store of apparatus with which enquiries are assisted and (for India) a very good medical library. The *Indian Journal of Medical Research* with the *Indian Medical Research Memoirs* are edited at the Institute.

Pasteur Institute of India, Kasauli.—Is situated at Kasauli in the Himalayas about 5,000 feet above sea-level. The Institute has an interesting history. A resolution to start an Institute in the Punjab, called the Pasteur Institute of India, similar to that in Paris, was passed at a meeting of private citizens held in Lahore on the 22nd of April, 1893. A central committee was formed soon afterwards but the Institute itself was not opened for the treatment of patients until August 9th, 1900. In spite of this delay it is believed to be the first Pasteur Institute to be founded in the British Empire. Besides antirabic treatment, the study, diagnosis and teaching of bacteriology and the investigation of tropical diseases was also a part of its original functions. With the opening of the Central Research Institute in 1905 and the advent of a bacteriological Institute in Lahore in 1914, this side of its activities came to a close and since that date antirabic treatment and research has formed its sole functions.

For the first seven years of its life the Institute, as the sole institution of its kind, in India, drew patients from all parts of the Indian Continent. Since that time the successive opening of other Pasteur Institutes has restricted its sphere of influence. At the present time it attracts patients from the Punjab and the United Provinces and other parts of North-Western India including Afghanistan and the North-West Transfrontier country. Within the last few years the policy of decentralisation

PLATE IX.

The Pasteur Institute of India, Kasauli.

of antirabic treatment has caused the opening of certain subsidiary centres dependent on the main institute for supplies of vaccine. Such centres have been opened at Lahore, Rawalpindi and Allahabad.

In spite of the friendly rivalry of its descendants the activities of the parent institute have never ceased to expand. Three hundred and twenty-one patients were treated in the first year of its existence. The numbers who have sought assistance and advice have gradually increased with the years until in 1926 no less than 8,623 persons or an average daily attendance of over 300 came for treatment to parent institute and its centres. These numbers are sufficient to justify the claim that the Kasauli Institute is the largest institution of its kind in the world.

The Institute, in common with all other institutes in the East, differs from the European Institutes in that its patients are nearly all actually bitten, many of them severely, as opposed to being merely in contact with and licked by rabid animals. Nearly 50 per cent. of all cases attending at Kasauli are severely bitten and 25 per cent. of these are of maximum severity. It is not surprising, therefore, that the general death rate (1.41 per cent.) is also higher than it is in Europe.

One of the features of the Institute is the detailed nature of the statistics published in its annual reports. These were originally compiled by Lieut-Col. Harvey and have been adhered to with little alteration ever since.

A further interesting feature is the large number of biting animals which are responsible for the attendance of patients. Dogs are responsible for 80 per cent. and jackals for 17 per cent. of cases, the remaining 3 per cent. include human beings, wolves, horses, cats, donkeys, cows, monkeys, foxes, mongooses, camels, buffaloes, goats, mules, bears, hyænas, leopards, sheep and tigers. Many of the stories told by patients of their encounters with wild animals are epics in their way.

The Institute has been most catholic in its choice of methods of treatment. From 1900 to 1907 the original Dried Cord Method of Pasteur was used. The Dilution Method of Hogyes was introduced in 1908 and remained in use until 1911. In

1912 carbolised vaccine was introduced and is still the main method of treatment at present. The claims of the etherised vaccine of Alivisatos and Hempt are being investigated in detail. The carbolised vaccine at present in use consists of a 1 per cent. suspension of brain matter in 0.5 per cent. carbolised saline solution. A daily dose of 5 ccs. of this vaccine is given to all patients for 14 days. In 1925, 820,000 ccs. of vaccine were made in the Institute.

The Institute is not a Government Institution but is still administered by the Pasteur Institute Association which gave its origin. It is supported by Government grants and voluntary contributions. All patients, of whatever degree, are treated free.

The Institute as it stands just now is very different from the original bungalow which was purchased for the purpose at the commencement of its career. The main building stands in a large estate and is surrounded by numerous outbuildings which include amongst others, a special hospital, houses for the staff, rabbit runs and breeding houses and a number of boarding houses for the different communities, Europeans, Indian chiefs and gentlemen, Bengalees and Parsees. In addition, there are quarters for indigent Indians who form the bulk of the patients.

An extensive organisation exists for the despatch and return of poor patients and their attendants to and from the Institute. On the certificate of a Magistrate or Civil Surgeon, free travelling, feeding expenses on the journey, free quarters, a daily food allowance while at the Institute and clothing are provided. These charges (except for railway travelling which is free as a concession) are ultimately recovered from the Local Bodies or Governments concerned. The crowd of patients of every class collected together every morning waiting for treatment is a unique sight and one which can only be fully appreciated when seen.

The medical staff consists of a Director, an Assistant to the Director and two Sub-Assistant Surgeons, one a lady.

Much research work into rabies and other subjects has been done by officers of the Institute since its foundation. Sir David

Semple, the original Director, the late Major G. Lamb, I.M.S., Lieut.-Col. W. F. Harvey, I.M.S., Lieut.-Col. A. G. McKendrick, I.M.S., and Lieut.-Col. Acton, all of whose names are well-known to workers on this subject, have all been directors of the Institute in times past.

The X-ray Institute of India.—This Institution is situated in Dehra Dun and is primarily a teaching Institute and a Supply Depôt for the equipment of the X-ray Departments of the Military Hospitals in India and of other Institutions under the control of the various Provincial Governments.

The Institute is well equipped with up-to-date apparatus for Radio diagnosis, Radiotherapy and Electrical treatment, both for demonstration purposes and for the treatment of patients. Two courses of Instruction in Radiography are held annually and some thirty medical men, Government servants either in the Military or in the Civil Departments, or private individuals attend each of these classes. Between two and three thousand X-ray Photographs are taken and an equal number of treatments, X-ray or Electrical, are given to Government servants during the year, and in addition a variable number of private individuals attend the Institute for treatment.

The Indian Military Hospital, Dehra Dun, supplies a constant stream of patients, who are transferred from other Military Hospitals throughout India to take advantage of the treatments offered in this Institute.

A small quantity of Radium is also available for those cases in which Radium treatment is of value.

Attached to the Institute are well equipped workshops in the charge of a skilled Electrical Engineer where repairs are made to damaged electrical equipment sent from all over India for the purpose, and wherein a certain amount of apparatus is manufactured.

There are small branch institutions in Delhi and in Simla, administered by the Institute in Dehra Dun, for the convenience of those who live in those towns.

1912 carbolised vaccine was introduced and is still the main method of treatment at present. The claims of the etherised vaccine of Alivisatos and Hempt are being investigated in detail. The carbolised vaccine at present in use consists of a 1 per cent. suspension of brain matter in 0.5 per cent. carbolised saline solution. A daily dose of 5 ccs. of this vaccine is given to all patients for 14 days. In 1925, 820,000 ccs. of vaccine were made in the Institute.

The Institute is not a Government Institution but is still administered by the Pasteur Institute Association which gave its origin. It is supported by Government grants and voluntary contributions. All patients, of whatever degree, are treated free.

The Institute as it stands just now is very different from the original bungalow which was purchased for the purpose at the commencement of its career. The main building stands in a large estate and is surrounded by numerous outbuildings which include amongst others, a special hospital, houses for the staff, rabbit runs and breeding houses and a number of boarding houses for the different communities, Europeans, Indian chiefs and gentlemen, Bengalees and Parsees. In addition, there are quarters for indigent Indians who form the bulk of the patients.

An extensive organisation exists for the despatch and return of poor patients and their attendants to and from the Institute. On the certificate of a Magistrate or Civil Surgeon, free travelling, feeding expenses on the journey, free quarters, a daily food allowance while at the Institute and clothing are provided. These charges (except for railway travelling which is free as a concession) are ultimately recovered from the Local Bodies or Governments concerned. The crowd of patients of every class collected together every morning waiting for treatment is a unique sight and one which can only be fully appreciated when seen.

The medical staff consists of a Director, an Assistant to the Director and two Sub-Assistant Surgeons, one a lady.

Much research work into rabies and other subjects has been done by officers of the Institute since its foundation. Sir David

Semple, the original Director, the late Major G. Lamb, I.M.S., Lieut.-Col. W. F. Harvey, I.M.S., Lieut.-Col. A. G. McKendrick, I.M.S., and Lieut.-Col. Acton, all of whose names are well-known to workers on this subject, have all been directors of the Institute in times past.

The X-ray Institute of India.—This Institution is situated in Dehra Dun and is primarily a teaching Institute and a Supply Depôt for the equipment of the X-ray Departments of the Military Hospitals in India and of other Institutions under the control of the various Provincial Governments.

The Institute is well equipped with up-to-date apparatus for Radio diagnosis, Radiotherapy and Electrical treatment, both for demonstration purposes and for the treatment of patients. Two courses of Instruction in Radiography are held annually and some thirty medical men, Government servants either in the Military or in the Civil Departments, or private individuals attend each of these classes. Between two and three thousand X-ray Photographs are taken and an equal number of treatments, X-ray or Electrical, are given to Government servants during the year, and in addition a variable number of private individuals attend the Institute for treatment.

The Indian Military Hospital, Dehra Dun, supplies a constant stream of patients, who are transferred from other Military Hospitals throughout India to take advantage of the treatments offered in this Institute.

A small quantity of Radium is also available for those cases in which Radium treatment is of value.

Attached to the Institute are well equipped workshops in the charge of a skilled Electrical Engineer where repairs are made to damaged electrical equipment sent from all over India for the purpose, and wherein a certain amount of apparatus is manufactured.

There are small branch institutions in Delhi and in Simla, administered by the Institute in Dehra Dun, for the convenience of those who live in those towns.

ASSAM.

King Edward VII Memorial Pasteur Institute and Medical Research Institute, Shillong.—The proposal to build an Institute in Assam for antirabic treatment was first put forward by Dr. Macnamara in 1906. In 1910 the Indian Tea Association supported a proposal which had been put forward that part of the Eastern Bengal and Assam King Edward VII Memorial Fund should be devoted to the construction of the Institute, and in 1912 Shillong was selected as the most suitable location. The Governing Body of the Indian Research Fund gave a grant of Rs. 25,000 towards the construction of the research laboratory and Rs. 15,000 for equipment and books. The foundation stone was laid on 4th November, 1915, and the buildings were completed in 1916. On the 5th January, 1917, a *communiqué* was issued to the Press to the effect that the Institute was ready to receive patients.

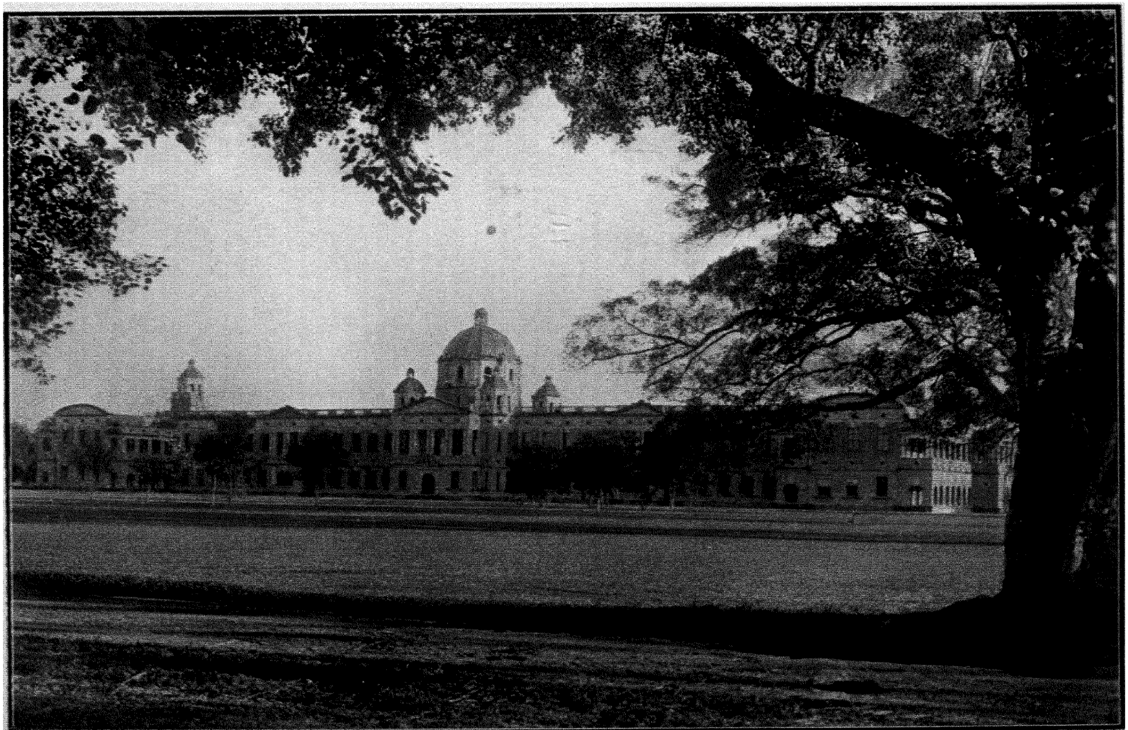
The main building of the Institute has a south frontage and consists of a central block with four wings. It stands in an estate of ten acres of plateau on a pine-covered hill at an elevation of 5,000 feet above sea-level. It is about a mile from the centre of Shillong and overlooks the Race-course and Golf-links. There is plenty of room for expansion.

As regards the work there are sections as follows:—

(*a*) *Pasteur Institute.*—During 1917 the number of patients who attended for antirabic treatment was 569. The number increased each year until it reached 2,371 in 1923. During this period patients were treated not only from Assam but also from Bengal and Bihar and Orissa. In June 1924, a Pasteur Institute was opened in Calcutta and all Bengal and Bihar and Orissa cases were henceforth treated here. The result was a drop in cases at the Shillong Institute in 1925 to 1,176 but they have since risen to approximately 1,500 annually.

(*b*) *Kala-azar and Research Section.*—Since the opening of the Institute research work has been carried out especially on diseases of importance to Assam such as kala-azar, Naga sore, malaria, etc., but also on general lines. Microscopical, cultural

PLATE X.



Imperial Agricultural Research Institute, Pusa, Bihar.

and serological examinations are also carried out on specimens sent to the Institute from all parts of the Province of Assam.

(*c*) *Vaccine Section.*—In order to deal with the general demands for vaccine from the Province, and especially in connection with the Influenza epidemic a vaccine section was sanctioned as an additional branch of the Institute work and was finally organised and put into running order in July 1919. The Section, however, stopped the manufacture of prophylactic vaccines in 1922 from which time it has acted as a distributing centre for Assam of vaccine prepared at the Central Research Institute, Kasauli.

A Kala-azar Ward is attached to the Institute and a great deal of experimental work has been carried out here in the treatment of the disease by various new drugs. This has also been a training centre for medical men of the Province in the diagnosis and treatment of kala-azar by the most modern methods.

In addition to the above a portion of the west wing is utilised by the Public Health Laboratory for the Province.

Provincial Public Health Laboratory, Shillong.—This occupies a part of the building of the King Edward VII Memorial Pasteur Institute, but is in charge of a separate officer. In this laboratory work of a definitely Public Health character is carried out, such as chemical and bacteriological analysis of water, chemical analysis of milk, ghee, butter, oils, atta, tea, etc., also examination of bleaching powder, alum, etc., and bacteriological tests of vaccine lymphs. The Laboratory also undertakes all the ordinary analyses required in connection with the diagnosis and treatment of patients in the Kala-azar Ward attached to the Institute, such as examination of blood films liver and spleen smears and cultures, also blood counts, colour index and examination of urine, stools and sputum.

The Laboratory further undertakes the examination of Urea Stibamine and arranges for its distribution for kala-azar treatment to the District Officers, thus taking a part in the scheme of Kala-azar Treatment Centres carried out in this Province.

BENGAL.

The School of Tropical Medicine, the Institute of Hygiene and the Carmichael Hospital for Tropical Diseases.— These three Institutions form parts of one scheme for post-graduate instruction and research in Tropical Diseases. The scheme was formed by Sir Leonard Rogers and it is to his energy and enthusiasm that the present organisation owes its existence.

The School, Institute and Hospital were built by funds which were raised by Sir Leonard from three chief sources.

		Original contribution (in round figures).	Present recurring cost (in round figures).
I.	Private funds ..	.. 8½ lacs of rupees	1 lac.
II.	Government of India	.. 6 lacs ,,	Nil.
III.	Government of Bengal	.. 4½ lacs ,,	4½ lacs
IV.	Research Fund Association	.. 2 lacs ,,	1½ lacs

The research side of the Institution has been in working for over six years, the teaching side for over five years.

The Teaching Side.—During the years 1922—26 medical men from all parts of India have been trained in Tropical Medicine to the number of 324 and in Public Health to the number of 59. In addition to these, large numbers of medical men have received special training in such diseases as Leprosy, Kala-azar, Hookworm Diseases, etc.

The chief object of the instruction at the School is to raise the standards of efficiency of the teachers and public health workers of India and to train research workers. Every Local Government has been invited to become a profit sharer in the benefits which are available at the School and the ideal which is aimed at is that a few of the picked medical men from each province should receive higher post-graduate training at the School every year. In this way there will be a supply of good teachers and public health workers and inevitably the standards of efficiency of the doctors of India will be improved. The result will be that the people of India will receive better medical treatment and more effective public health service.

The Research Side.—This aims at the discovery of better methods of treating and preventing the great disabling diseases of India; already many important advances have been made by the workers at the School.

Kala-azar is a fatal disease which kills thousands of people in Bengal, Assam and other parts of India. The Kala-azar Research Department has demonstrated the practicability of establishing Out-patient Dispensaries for the treatment of this disease at a very small cost. Such Dispensaries are now established in many places in Bengal. A valuable means of diagnosis has been discovered and recently the workers at the School have discovered that a species of sandfly is probably the carrier of the disease. Owing to this discovery research workers in various parts of the world are concentrating on the task of demonstrating the truth of this hypothesis. If as we believe it will finally be shown that the sandfly is the carrier, the School will have the credit of solving the last of the great problems of tropical medicine.

The work of the Leprosy Department is well-known throughout the world. The lines of treatment of this disease which have been worked out at the School are now adopted by most of the countries in which leprosy occurs. The whole outlook on life of the leper has been revolutionised. He is no longer the hopeless victim of an incurable disease and an outcast from society, he has a good prospect of recovery and so comes forward for early treatment instead of concealing his disease until his condition is hopeless.

It is impossible to deal adequately with all the work which has been done at the School in a brief statement like this, but a few of the advances which have been made by our workers may be mentioned.

The Skin Diseases of India have been systematically studied for the first time and a text-book on the subject is in preparation.

The causation of Epidemic Dropsy has been worked out with some degree of certainty, and it is likely that our work will be found to have a most important bearing on beri-beri which is

either the same disease or at any rate closely related to epidemic dropsy. It is believed that the crux of the problem is the proper storage of rice.

A fever which had not hitherto been recognised in India has been discovered and its diagnosis has been placed on a sound footing. Since the publication of our accounts of this disease it has been found to be common and widespread in the tropics.

The distribution of Hookworm Disease in India has been worked out, methods of prevention suitable for various localities have been published and we are now in a position to form an accurate idea of the real importance of the disease in the places in which it occurs. Hitherto we were unable to form any true estimate of the damage which is done by the disease, so that steps for its eradication could not be planned on sound working basis.

Cholera infection appears to persist in many parts of India, little was known of the conditions under which this occurred, one of our workers in conjunction with the Chief Medical Officer of the Asansol Mining Settlement has been at work on this problem and the results already obtained promise to be of immense value.

Many Indigenous Drugs have been analysed and tested and several have been discovered to be of real value. This work is of great importance as the practitioners of scientific medicine have often been accused of adopting an attitude of antagonism towards the use of valuable remedies of indigenous origin. Our aim is to examine the drugs which are commonly believed to be of value and to sift the wheat from the chaff.

Valuable Malaria Surveys have been carried out in several areas and measures have been recommended for controlling the disease in these places. As this work progresses it is expected that preventive measures will be devised which will be suitable for the various localities in which the disease occurs.

The following text-books have been written by members of the staff, some of them in collaboration with other workers.

Major R. Knowles, I.M.S.

(1) Introduction to Medical Protozoology.

(2) Lecture Notes in Medical Protozoology.

Major Knowles and Dr. Senior-White.

(1) Malaria, its investigation and control.

Lieut-Col. A. D. Stewart, I.M.S., and Major Boyd, I.M.S.

(1) Public Health Chemistry.

Dr. E. Muir.

(1) Kala-azar, its diagnosis and treatment.

(2) Handbook on Leprosy.

Dr. E. Muir and Dr. L. E. Napier.

(1) Kala-azar.

Dr. Muir and Sir Leonard Rogers.

(1) Leprosy.

The training of young Indian Research Workers is one of the important functions of the School. Many young medical men have had the opportunity of collaborating with first class experts and of obtaining an insight into the methods of research, already some of them have won their spurs and at least one discovery of first class importance has been made by a pupil of the School.

The Hospital and Out-patient Departments.—The chief purpose of the hospital is to keep the research laboratories in touch with practical medicine and to supply suitable patients for the study of the diseases which are being investigated. The School, thanks to the foresight of Sir Leonard Rogers, is very fortunately situated in this respect. Owing to the large population of Calcutta and to the fact that it is the "Charing Cross" of the most populous parts of India the supply of material is inexhaustible. From the humanitarian point of view the hospital also plays an important part. The facilities for diagnosis and treatment of obscure diseases are far greater than those existing in any other hospital in the East. The Out-patient Departments which were opened with the object of obtaining material have become so popular that an embarrassing number of patients come for diagnosis and treatment. The Pasteur Institute which was recently opened is already one of the largest in India and large numbers of patients are saved the trouble and expense of a long journey to Shillong or Kasauli. Also many are now treated

temple of Parali-Vaijnath from which the village, now the important industrial area, known as Parel takes its name.

The earliest reference to the present building is in 1673 when it belonged to the Jesuits, who erected it on the site of the temple which they doubtless destroyed. When Bombay was ceded to the British the Jesuits claimed the church and convent at Parel but after much contention the Monastery and lands were confiscated in 1719 by the Governor of Bombay by whom it was used as an occasional residence. In 1829 it became the permanent official residence of the Governors of Bombay and so it remained till 1885 when Lady Fergusson, the wife of the Governor, died there of cholera, as a result of which tragedy the place was abandoned. It remained vacant till 1887 when plague first made its appearance in Bombay when the building was used as a plague hospital.

Two years later, in 1899, Mr. Haffkine, who had been preparing his prophylactic vaccine at various temporary laboratories in the city, obtained permission to take over Old Government House for the manufacture of his vaccine. It was then known as the Plague Research Laboratory and one of its principal functions to this day has been to manufacture Haffkine's Plague Prophylactic.

The laboratory continued to expand and came to function as the principal centre for research into diseases other than plague and as a diagnostic centre for the clinical requirements of Western India and so to indicate the expansion in its function, its name was changed in 1906 to that of the Bombay Bacteriological Laboratory.

More recently, owing to a further expansion of its activities to include antirabic, pharmacological and biochemical research, its name was again changed in 1925 at the instance of the present director, to that of "The Haffkine Institute" in memory of the great investigator who was its founder and its inspirator and who may be regarded as one of India's greatest benefactors.

During the years of its existence close on thirty million doses of vaccine have been made and issued to all parts of

India and the middle East, from East Africa on one side to China on the other. Worthy as its efforts have been in the origination and improvement in the technique of plague vaccine it has equally high claims to fame on the research side. When the tide of the great plague pandemic broke in India in 1896 and began spreading up the mainland of the peninsula like wild-fire, the attention of the scientific world was focussed on the terrible drama which was being enacted. In these early days Haffkine's laboratory was the Mecca for the world's "savants" either solitary or in commissions and every one who had an hypothesis to test came to Bombay hoping to stem the rising tide which threatened to make of India one vast charnel house.

The conclusions of most of these enquiries may be passed over for it was not till the British Plague Research Commission came out in 1905 that the true facts of plague transmission became known. Working on lines suggested by Liston (afterwards to be one of the most notable directors of this laboratory) this Commission worked out the whole question of transmission and showed by a series of masterly researches which were carried on till 1912 that the disease is primarily an epizootic of rats and is transmitted from them to man by the agency of rat fleas. Once these facts were known, and they have never been challenged, a most powerful weapon of prevention was placed in the hands of sanitarians and public health officials. Research into the problems of plague has been going on continuously in this laboratory ever since and at present the chief object of these investigations is to improve the quality and potency of Haffkine's prophylactic and to study drugs likely to be useful in the treatment of the disease.

Another notable investigation which was carried on in 1906-07 was into the transmission of relapsing fever as a result of which the body louse was proved to be the natural carrier of this formidable disease. This successful piece of work set the seal on the observations made twenty years previously on the clinical aspect of the disease by one of Bombay's greatest investigators Henry Vandyke Carter. In

addition other notable researches have been carried on such as that on the natural history and transmission of guinea-worm which was proved to be carried from one man to another by the agency of infected cyclops (water fleas) which infest the wells of the presidency. In addition work of permanent value has been done on snake-bite, malaria, tuberculosis, water-borne disease, schistosomiasis, sprue, leprosy and other diseases prevalent in Bombay.

The Institute maintains a large number of poisonous snakes from which venom is collected for the manufacture of anti-venomous sera and the process of venom extraction is counted as one of its principal attractions to visitors.

A great effort to increase the educational functions of the Institute was made in recent years by Lt.-Col. W. G. Liston who aided by a generous grant by Sir Dorab Tata put forward a scheme for the foundation of a School of Tropical Medicine. Just when the scheme was complete and about to come to fruition the Inchcape axe fell and the scheme had to be abandoned on financial grounds.

Since his time the new buildings raised for this object have been opened up for antirabic treatment and fine laboratories fitted out for the study of indigenous drugs and for biochemistry.

The following have been directors of this Laboratory since its inception:—

Waldimir Mordecai Haffkine	.. 1899 to 1904
William Burney Bannerman	.. 1904 to 1911
William Glen Liston	.. 1911 to 1923
Frederic Percival Mackie	1923 till the present date.

The Vaccine Institute, Belgaum.—An excellent Institute with a laboratory attached. Supplies Bombay Presidency, also Zanzibar, Aden, Goa and the Persian Gulf, etc. Doses issued (1924) 1,177,570 with 99 per cent. or over success rate with primary vaccinations. The vaccine is passed through rabbits and tested clinically before issue. A training class in vaccination is held.

BURMA.

Pasteur Institute of Burma, Rangoon, was opened in 1915 and is a double storeyed building. The ground floor is occupied by the Antirabic Department, consulting rooms, waiting rooms, store rooms, and officers. The upper storey has large and well-lit laboratories. The kitchen is at the west and the Serological Department at the east. The two main laboratories in the centre are devoted to Research Work and Clinical Pathology. In the grounds are quarters for indigent patients and for the staff, and also animal houses. The Institute has its own gas and refrigerating plants.

The average number of patients bitten by rabid animals treated during the year is about 1,100. At present two-thirds of these cases come from Rangoon itself.

The Harcourt Butler Institute of Public Health, Rangoon, was opened by His Excellency the Governor in January 1927. It acts as a Training School in Hygiene, as a Central Laboratory for Public Health work and as a centre for health propaganda. It has a Bacteriological and a Chemical Section where water and food analysis, etc., is carried out. Medical Students and Public Health Inspectors and School Teachers are trained in Hygiene at this Institute by Officers of the Public Health Department. A course of study is also conducted for sub-assistant surgeons leading to a Government License in Public Health. It is proposed to house a Malaria Bureau in the Institute. A Teaching Museum is being created in a room on the ground floor.

Vaccine Depot, Meikteila.—All vaccine lymph used in the Province is manufactured by the Public Health Department at the Provincial Vaccine Depôt, Meikteila. The Depôt was formerly in charge of the Civil Surgeon, Meikteila, but from 1st March, 1927, a whole time Director has been appointed. He is aided by an Assistant Director of the Civil Sub-Assistant Surgeon class and a small subordinate staff. The Director supervises the training class for vaccinators. This class is of three months' duration and four successive classes are held in the year.

CENTRAL PROVINCES.

Central Provinces Vaccine Institute, Nagpur.—Bovine calves are used for the manufacture of lymph. On admission to the Institute these animals are segregated in a special area for 10 days. During this period they are given an arsenic bath to get rid of ticks and their blood smears are sent to the Veterinary Hospital for examination. If any animal is found to be suffering from any disease or the Veterinary Surgeon gives an unfavourable report on the blood smear (piroplasmosis), the animal is rejected and sold. After 10 days animals are taken to the waiting stable and utilized for manufacture of lymph. The potency of the lymph is kept up by frequent passage through rabbits to buffalo calves. One day previous to the operation the calves' abdomen, flanks and perineum are shaved. On the day of the operation the razor is passed over this area again. Up to January last linear incisions about an inch apart were made with the blunt point of a scalpel and the seed lymph rubbed in. Since then the whole area has been scarified with special fork-shaped scarifiers and the lymph rubbed in. The yield of lymph by the former method was 34.49 grams (average), and by the latter method 77.17 grams (average).

After operation the animals are kept in a fly-proof maturing stable for 5 days and on the 6th morning after washing the operated area well with neutral soap and water, it is covered with a sterilized towel and is well moistened with a thin stream of warm water. The pulp is then scraped away and weighed. After weighing it is mixed with equal parts by weight of glycerine and water-dilution 1.4 (one part pulp and 4 parts of glycerine mixture), and first ground in a glass mortar and then in a Felix and Flucks' grinding machine. It is finally stored in the ice-chest (temperature 5°C. to 10°C.) in test-tubes of about 30 c.c. size each. Storage is from 4 to 8 months before despatch. Before despatch it is subjected to bacteriological tests —(plating on agar). Not more than 15 colonies of staphylococci are allowed per plate. If the plate shows anthrax, streptococci and pyocyaneus, etc., it is rejected.

Lymph is supplied to the vaccinators in the Province in 1 c.c. vials (20 doses). Total annual manufacture 757,840 doses. Cost per dose 6 pies. The animals after healing are disposed of in the local markets. Average loss per animal Rs. 3. Average purchase cost of animals Rs. 13 per animal.

MADRAS.

The King Institute of Preventive Medicine, Guindy.—The King Institute is situated at Guindy about seven miles from Madras. It was founded in 1903 and named after Colonel W. G. King, C.I.E., I.M.S., then Sanitary Commissioner of Madras who had been chiefly responsible for its inception. At first its main work was that of supplying vaccine lymph to the Madras Presidency but in course of time its activities extended very greatly and at present are as follows:—

For the whole Presidency—

(1) The only vaccine lymph depôt.

(2) The main general bacteriological laboratory for all bacteriological and serological diagnostic purposes and for the manufacture of all vaccines except plague, as also of sterile solutions and media, etc.

(3) The only Government Public Health Laboratory for the bacteriological and chemical examination of all water supplies, milk, food, etc.

(4) The laboratory for the Public Analyst.

(5) A cold storage and distributing centre for sera for human and veterinary use.

(6) A general clinical and Public Health Research Laboratory and the centre for three mobile investigation units.

For all the Madras Hospitals except the General Hospital:

(7) The clinical bacteriological laboratory—an Institute car collects material daily.

The Institute covers several acres of ground and consists of a main building for the Bacteriological and Chemical

work, a new subsidiary block for Vaccine Lymph work and many out-buildings for calves, animals, stores and offices. The Institute has its own water and gas supply, runs a large cold store and makes its own ice. In the grounds of the Institute there are a set of experimental water filters with storage tanks and sand and mechanical filters.

The staff consists of a director and an assistant director belonging to the Medical Research Department of the Government of India, a public analyst, 1 civil surgeon, 7 assistant surgeons, 2 non-medical gazetted senior assistants (Bacteriologist and Chemist in the Public Health Section), 1 sub-assistant surgeon and 5 junior assistants. In addition there is a large staff of laboratory attendants and other subordinates which swell the total staff to 164.

The Vaccine Lymph Section manufactures and issues over two million doses of glycerine lymph annually. This is distributed chiefly to the Madras Presidency. Supplies are also made to the military authorities in Southern India, to French India, and to a certain extent to Ceylon.

The General Bacteriological Section has been of increasing use to the Presidency particularly in the performance of Wassermann tests of which 13,000 were done last year and in the manufacture of stock and autogenous vaccines. In the last three months owing to heavy demands 400,000 doses of cholera vaccine were manufactured.

In the Public Health Section the examination and investigation of water supplies has always been a prominent feature. During the course of each year, samples of water from every protected water supply, whether belonging to municipalities, railways or jails, are collected by the Institute sample-takers, brought to the Institute and examined. Samples from any proposed source of supply are also submitted for opinion and report. Experiments are carried on with the experimental filters under the direction of the Committee on Water and Sewage Purification, of which the Director of the Institute is the secretary. During the past few years this section has taken a leading part in an investigation into the water supply of Madras

City and has been instrumental in giving the Madras Corporation much useful advice in this subject.

The Public Analyst has fixed standards for certain food supplies with a view to bringing the Madras Adulteration of Food and Drugs Act into operation. In addition to his own work he controls the Public Health Section.

The work done by the Mobile Investigation Units, the first of their kind to be formed in India, have justified their existence. The annual report for 1926-27 gives a good idea of their activities, which extended over 14 different malarial surveys and bacteriological researches.

The King Institute has a good record of Medical Research work done by officers while working on its staff. Colonel King was and still is one of the leading authorities on tropical sanitation and of modern methods of vaccine lymph production. The Protozoological researches of Captain (now Lt.-Col.) Christophers while Director are well known. Medical Entomology has formed a very fruitful field for research in the hands of Majors Patton and Cragg, who worked in collaboration at the Institute for some considerable time. The experience gained by these officers culminated in the publication of their well-known text-book on medical entomology. The Institute was the head-quarters of the Kala-azar Commission in Madras in 1912.

The interest which has always been taken in problems connected with water purification originated with the work done by Major (now Lt.-Col.) Clemesha while Sanitary Commissioner in Madras. The results of his researches on tropical standards of purity were published in many of the reports issued from the Institute, and formed the subject-matter of his book on "Water Supplies in the Tropics."

The field covered in recent years has been a wide one and includes investigations into vaccine lymph, filariasis, kala-azar, relapsing fever, malaria, dysentery, cholera, puerperal sepsis and the purification of water. The results of these investigations by the members of the staff have been

published from time to time in Indian medical journals and in the annual reports of the Institute.

The Pasteur Institute of Southern India, Coonoor.—The establishment of a Pasteur Institute at Coonoor was rendered possible by the generosity of Mr. Henry Phipps, an American, who gave several lakhs of rupees to the Viceroy, Lord Curzon. One lakh was handed over to the Madras Government to help in the establishment of a Pasteur Institute in Southern India. At the time it was considered essential that a Pasteur Institute should be located in a cool climate and Coonoor was agreed upon as the most suitable location, being cool and on the railway and fairly central. The Institute was opened for the reception of patients on April 1st, 1907.

From this date to 15th November, 1908, 404 persons were treated with dilutions of cords preserved in glycerine in an ice chest till required for use. From 16th November, 1908 to 31st January, 1912, 2,464 persons were treated by Hogyes' dilution method. On the 1st February, 1912, treatment with carbolised vaccine was commenced and, up to the 28th February, 1927, 28,860 persons have been treated with this vaccine. The total number treated from 1st April, 1907 to 28th February, 1927 is 31,729 with a mortality rate of 0·98 per cent. and a failure rate of 0·70 per cent.

Up to 1922, all persons bitten by rabid animals had to come to Coonoor for treatment. In the meantime experiments carried out at the Institute had shown that carbolised vaccine did not suffer any appreciable loss of immunizing power in the heat of the plains during the period allowed for its transit and use. It was therefore decided to establish centres for treatment with vaccine prepared and sent out by the Institute. Since 1922, more than 60 such centres have been established in hospitals in the Presidency and in Indian States. The vaccine for each patient or batch of patients is supplied as required and is sent out in sealed ampoules in two lots at 4 days' interval. Instructions are printed on the label that the vaccine should not be used more than 14 days after the date of its despatch. Since 1922 nearly

18,000 persons have been treated at these centres with mortality and failure rates slightly lower than those for persons treated at the Institute during the same period. Since the decentralisation of the treatment has been effected, the total number of persons treated annually has increased by over 1,000 while the number treated at the Pasteur Institute has fallen from about 3,500 to 500.

In addition to routine work, research work on Rabies, Kala-azar, Filariasis and on Entomological and other subjects has been carried out by workers at the Institute and the results have been published in *The Indian Journal of Medical Research.* Since 1918, accommodation has been given to the workers of the Deficiency Diseases Inquiry under the Indian Research Fund Association.

PUNJAB.

The Punjab Vaccine Institute.—The Punjab Vaccine Institute is engaged in the manufacture and issue of vaccine lymph over a very wide area. Not only is vaccine lymph issued to all Civil and Military authorities and private medical practitioners in the Punjab, North-West Frontier Province and the Punjab Indian States but its activities extend to Tibet, Nepal, Chinese Turkistan, Arabia and Persia.

The average number of doses issued during the past three years is 3,271,298. The Forster-Java method is employed for vaccine lymph production, that is (1) Buffalo Calves are vaccinated with cow calf lymph; (2) Cow Calves are vaccinated with Rabbit lymph; and (3) Rabbits are vaccinated with Buffalo Calf lymph. The lymph is glycerinated with a 50 per cent. Glycerine Distilled Water Mixture in the proportion of 1 part of pulp to 4 parts of mixture, by weight. Vaccine lymph for issue is "chloroformed" for half an hour immediately trituration with glycerine mixture is effected.

Since the adoption of the three-animal method of vaccine lymph production, the average yield of pulp per calf has increased threefold and is now per Buffalo Calf 91·0 grammes and per Cow Calf 27·7 grammes average yield. The quality of

vaccine lymph has also improved and the case success in primary cases is 98·19 per cent. and in re-vaccinations 72·52 per cent.

The Institute in addition to being self-supporting returns a substantial profit to Government annually.

The Punjab Vaccine Institute carries out the following additional activities :—

(1) The training of Sanitary Inspectors in Hygiene and Sanitation and the technique and practice of vaccine lymph preparation and vaccination.

(2) The training of District Vaccinators in Elementary Hygiene and Sanitation and practical instructions in vaccine lymph preparation and vaccination.

(3) Practical instructions to Lady Health Visitors in vaccine lymph preparation and vaccination.

(4) Practical instructions to Final Year medical students of the King Edward Medical College in vaccine lymph preparation and vaccination.

UNITED PROVINCES.

Provincial Hygiene Institute, Lucknow.—The work of this Institute is at present carried on as a temporary measure in the King George's Medical College. A new institute is being built at a cost of about four lakhs and the first portion of it will be completed in April 1928. Projected additions to contain the Research Laboratories to cost three more lakhs, etc., are under preparation. The work carried on includes (1) Under-graduate classes in Hygiene and Public Health for the M.B., B.S., Lucknow University. (2) Classes for the Diploma of Public Health, Lucknow University. (3) Classes for the License in Public Health of the State Faculty of Medicine, U. P. (4) Classes for the Apprentice Sanitary Inspectors and Sanitary Inspectors. (5) Examination of Chief Sanitary Inspectors. (6) Examination of Medical Officers of Health in Provincial Municipal Law. (7) Post-graduate courses to the members of the Provincial Medical Service in State Medicine. (8) Cinema Production. (9) Grade examination of Medical Officers in charge of Travelling Dispensaries. (10) Training of Laboratory Assistants.

(11) Examination of water, food, disinfectants, etc. (12) Research.

Government Bovine Lymph Depot, Patwadangar.—The manufacture of calf lymph for the supply of the Vaccination Department of the U. P., certain Native States in the U. P. and Rajputana and the Military Department in the U. P. and Rajputana. About 2½ million doses of calf lymph are produced annually in the Depôt.

Chemical and Bacteriological Municipal Laboratories.—These have been established under the auspices of the Public Health Department for the testing of municipal water supplies and food supplies in the following towns: Allahabad, Benares, Cawnpore, Agra, Meerut, Bareilly, Muttra, Fyzabad, Mussoorie, and others are projected. In all these laboratories bacteriological examinations are carried out for private practitioners in accordance with the scale of fees laid down by the Government of India for Government institutions.

4. MEDICAL, HEALTH AND RESEARCH ASSOCIATIONS AND SOCIETIES.

Space does not permit of an adequate account of these Associations and Societies which deal with many important aspects of medical work in India. The following is a very brief mention of the more important of these:—

Indian Red Cross Society.—Its activities embrace arrangements for the sick and wounded and provision of comforts to H. M. Forces, Tuberculosis Work, Child Welfare, Work Parties for the Provision of Clothing, etc., Nursing, Health and Welfare Work, etc.

St. John Ambulance Association (Indian Council).—The Indian Council was constituted in 1910. It has since issued 106,327 certificates of proficiency in First Aid, Home Nursing, Home Hygiene and Sanitation and 4,917 tokens for special proficiency in these subjects.

British Empire Leprosy Relief Association (Indian Council).—The main Association was founded in England

in 1924. The Indian Council was inaugurated at His Excellency the Viceroy's invitation in January 1925, at Delhi. His Excellency the Viceroy is President. A sum of Rs. 19 lakhs has been collected. The activities of the Association include (*a*) Research, (*b*) Training of Doctors in Special Leprosy Treatment, (*c*) Propaganda, (*d*) Improvement of Leper Asylums in the various provinces.

National Association for supplying Female Medical Aid to Women of India.—Was founded by the Countess of Dufferin in 1866. The Association is subsidized by Government of India with a grant of Rs. 3,70,000 annually for the maintenance of the *Women's Medical Service of India.*

Lady Reading Women of India Fund.—Was opened by H. E. the Countess of Reading with the object, among others, of establishing an *Indian Nursing Association.* In connection with the Fund is the Lady Reading Hospital, Simla, and a Hostel for Indian nurses at Delhi.

All-India Maternity and Child Welfare League.—Was initiated by Lady Chelmsford and aims at establishing Child Welfare centres in most of the larger towns of India. It aims at training of midwives, instruction of mothers, antenatal work, care of babies, etc. There are child welfare centres under the League, Indian Red Cross and other bodies at Bombay (Lady Willingdon's Maternity Homes, Bombay Infant Welfare Society founded by Lady Lloyd with 8 child welfare centres), Poona (Seva Sadan Society), Surat (Henderson Ophthalmic Scheme for Treating Preventable and Curable Blindness), Delhi (Training School for Health Visitors, etc.), Madras (many centres under Provincial Branch of League and Red Cross Society, Co-operative Midwives Scheme, etc.), Calcutta, Dacca, Lahore, Karachi, Nagpur, Bijapur and many other places, including Indian States.

The Lady Reading Health School, Delhi.—Is supported by the Lady Chelmsford All-India League except for a grant of less than a third of the budget, given by the local Government. It has existed for nine years and its past pupils are

working in all parts of India. The course is based on the syllabus of English institutions of a similar kind, and lasts for nine and a half months. The teachers are experienced and the school buildings are new and well adapted for the purpose. There is a model child welfare centre close by which provides for the students' practical work. Candidates applying must be in possession of a midwifery diploma. Ten scholarships of Rs. 40 per mensem are offered for suitable students.

The Punjab Health School, 15, Abbott Road, Lahore.—Was started in 1922, with the object of training educated Indian women, native to or domiciled in the Punjab, as Health Visitors. The All-India Lady Chelmsford League was responsible for this enterprise, and engaged two qualified workers from England as staff. The School and the Staff, to whom an Indian worker has since been added, were taken over, on April 1st, 1927, by the Provincial Government, the scheme being placed under the control of the Director of Public Health. Women of good education, who must possess the Diploma of the Punjab Central Midwives' Board (an equivalent of the English Central Midwives' Board qualification), and be between the ages of 25 and 35, are eligible for scholarships, and the period of training is 6 months, during which time the pupils are in residence at the Public Health School, Lahore, where the English staff also reside.

The training is both theoretical and practical, and is a modification of the English Ministry of Health Course for Health Visitors, though training in the teaching of the native midwives, lecturing, home visiting of expectant mothers and mothers and infants work at an Infant Welfare Centre, record-keeping, etc., are emphasised.

On leaving the School, the Health Visitors are sent to work under local authorities, both in municipal and in rural areas, in the Province, and part of the duty of the Principal of the School, is to supervise their work, acting as an advisor to the employing authority.

On the occasion of her tours, the Principal does as much Health Propaganda work as possible, lecturing and holding

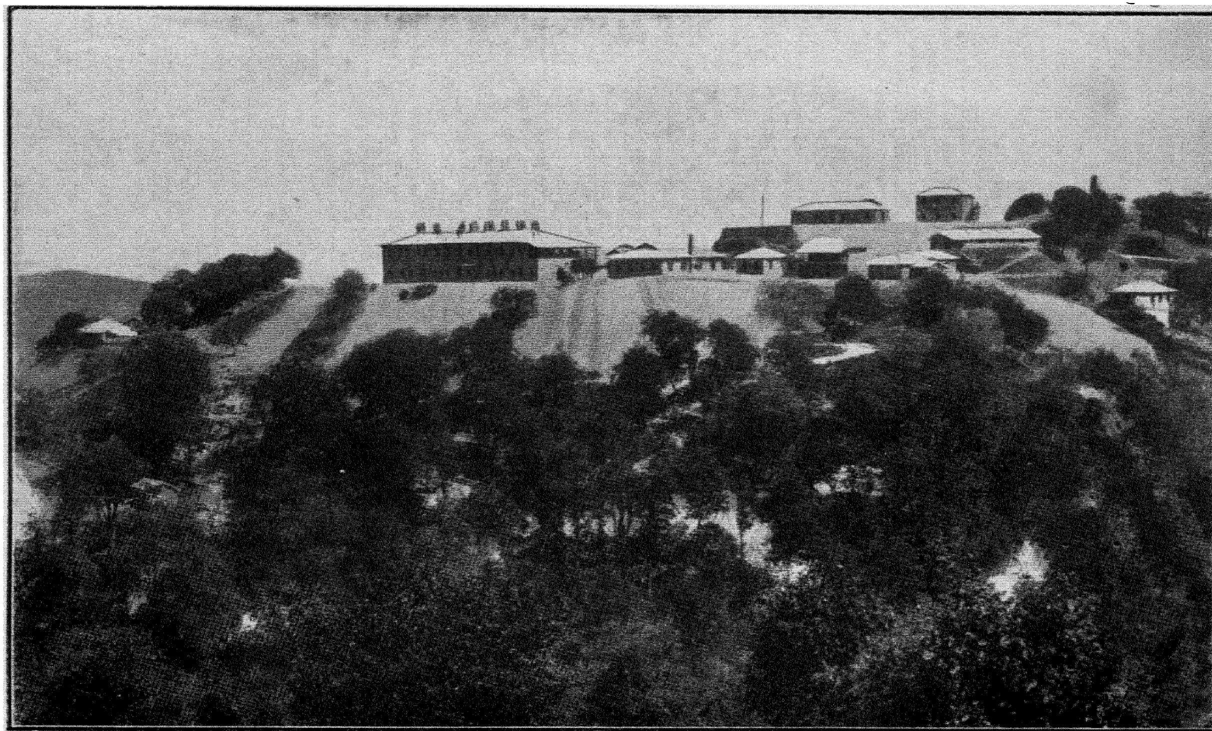
informal meetings in schools and colleges, and among purdah women, and the general public.

The Central Co-operative Anti-Malaria Society, Ltd., Calcutta.—This society has been registered under the Co-operative Society's Registration Act on 5th July, 1927. Its aim is to create autonomous rural units, in each village, throughout the province of Bengal, whose function will be to control malaria and other diseases like kala-azar, in their respective area. Altogether 1,200 rural units have been formed, of which 431 were registered. Since for carrying on this prevention work against malaria and kala-azar, help of a medical man is necessary, four or five such units federate to maintain by their combined resources a medical man who, besides giving medical relief to the locality, acts as their health officer. On account of its usefulness supplementing the work of the local bodies, Government of Bengal has helped the movement by occasional contribution to the Central Society as well as by annual grants to the rural units through the local bodies. The Central Society has a Board of Directors consisting of 9 Directors, two-thirds of whom are elected by the members of the Central Society, one-third by representatives of rural societies. Though the name of the Central Society might indicate that the Society's activity is confined to malaria, yet in fact it has gradually included within its scope of work control of diseases like kala-azar, cholera, etc., etc.

The Bengal Health Association.

Indian Research Fund Association.—Was constituted in 1911 by the Government of India with a recurring grant of Rs. 5 lakhs annually for the endowment of medical research. The Association organises and carries out a large part of medical research now conducted in India. It employs a number of research workers, finances enquiries, makes grants to cover expenses of researches carried out by Government research officers and others, and in all possible ways encourages the prosecution of medical research in India. Its activities cover a very wide field and have enormously added to the scope and extent of work carried out. Its journal is *The Indian Journal of Medical Research*

PLATE XI.



The Imperial Institute of Veterinary Research, Muktesar.

and there are also *The Indian Medical Research Memoirs* for monographic studies. The Association also assists financially in the publication of approved works on medical research. The Association consists of a Governing Body and a Scientific Advisory Board on which latter are representatives of all the major medical research laboratories of India. In connection with the Association is a Conference of Medical Research Workers held annually and attended by delegates from all India.

5. VETERINARY COLLEGES AND INSTITUTIONS.

Imperial Institute of Veterinary Research, Muktesar.—Muktesar is situated in the Himalayan foothills in the Kumaon District of the United Provinces, 24 miles by road from Kathgodam, R. & K. Railway, and at an altitude of 7,000 feet.

The Institute had its beginnings in 1890 when an officer was appointed to work at anthrax and anthracoid diseases in Poona under the Educational Department. In 1892 this officer was appointed Professor of Bacteriology and Comparative Pathology and Imperial Bacteriologist to the Government of India. The facilities at Poona for research into the more severe contagious diseases of animals were, however, found inadequate, and in 1893, under orders of the Government of India, the Imperial Bacteriologist, accompanied by the Principal of the Lahore Veterinary College, proceeded to investigate a more suitable site, and Muktesar, on account of its isolation and availability of material for research into rinderpest (cattle plague), was selected as a good location for the erection of a laboratory. It was not, however, until 1898 that the laboratory was completed and furnished with necessary equipment. In 1899 the laboratory was totally destroyed by fire and was re-erected in 1903.

The area of land occupied at Muktesar, known as the Muktesar Reserved Forest, covers about 8 square miles. The main laboratory building is two-storied and constructed of stone, with wide verandahs running along the south and west side and with work benches facing north. Of accessory buildings may be mentioned the Sterilizing House, the Mallein Laboratory, the Centrifuge Room and the Power House—all of which are located

close to the main building. There is also a Post-mortem House with incinerators, a Small Animals' House and a laboratory building temporarily in use for a special tuberculosis enquiry. In addition, there are a number of stone buildings and thatched sheds for housing animals under experimentation, besides six out-kraals situated round the circumference of the estate for accommodation and segregation of cattle before they are required for the use in the inner sheds.

The Library is situated on the ground floor of the main building. It contains some 6,000 volumes of journals, 1,600 text-books and 1,400 miscellaneous publications. The number of periodicals now received amounts to 183.

A total staff of about 1,000 are employed, including technical, mental, engineering, farm menials and daily labour.

Activities of the Institute.

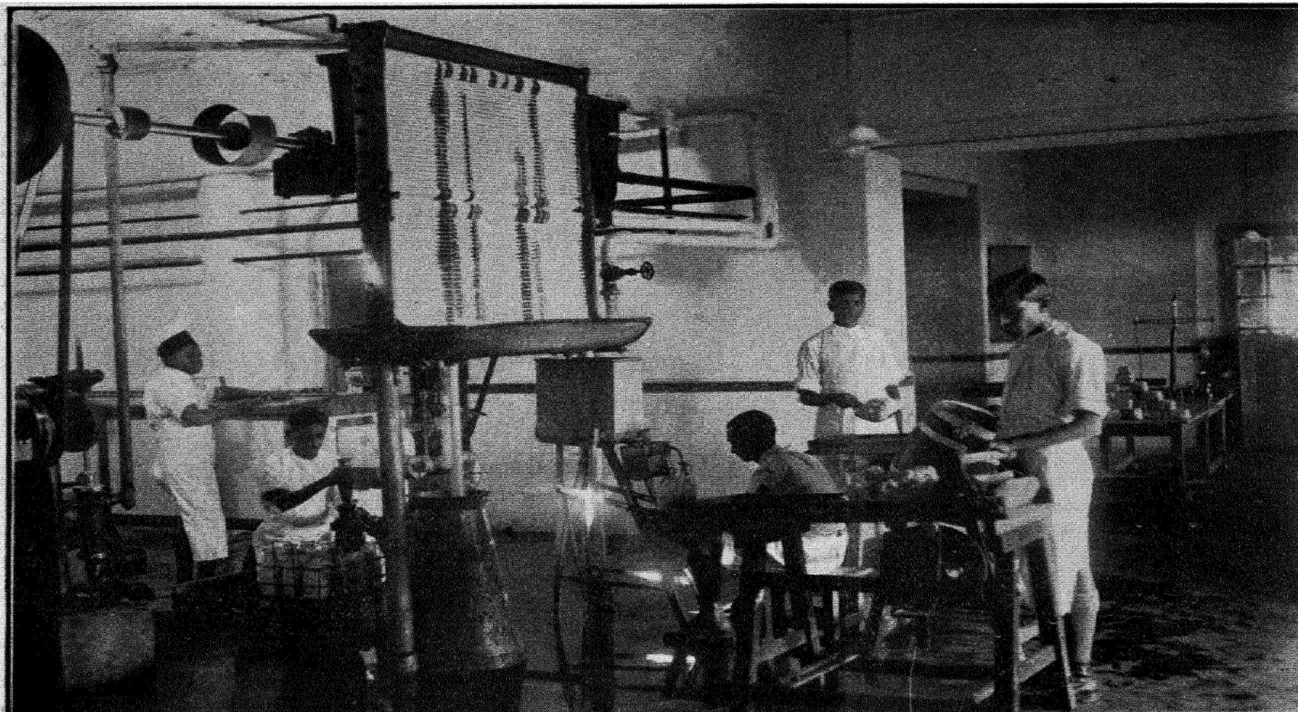
The functions of the Laboratory as originally laid down are: "To investigate diseases of domestic animals in all Provinces in India and to ascertain, as far as possible, by biological research both in the laboratory and, when necessary, at the place of out-break, the means of prevention and curing such diseases."

A most important function of the Institute has come to be, in the course of its development, the preparation on a very large ile of certain products for the prevention of the more formidable cattle diseases of India. The following figures representing the quantities of sera and vaccine issued during the financial year 1926-27 indicate the extent to which manufacture of such products is undertaken by the Institute.

(1) *Anti-rinderpest serum.* Issued 5,380,187 (5 c.c.) doses, of which 491,626 doses were for the serum-simultaneous inoculation, the remainder being for preventive inoculation.

(2) *Anti-hæmorrhagic septicæmia serum and vaccine.* The serum is used at the scene of outbreaks to cut short the spread of the disease, the vaccine to inoculate cattle in notoriously affected districts just before the advent of the rains when cattle are most likely to be attacked. During the year 363,709 doses of

PLATE XII.



Pasteurizing and bottling of milk by students—Imperial Institute of Animal Husbandry and Dairying, Bangalore.

the serum and 288,350 doses of the vaccine were issued for these purposes.

(3) *Anti-blackquarter serum and vaccine.* Issued 28,298 doses of the serum and 130,100 doses of the vaccines, comprising so-called "pillules" manufactured by the older (Arloins) method, and 79,600 (5 c.c.) doses of "aggressin." The production of the latter vaccine, which is perfectly safe and a sure preventive against the disease, constitutes a notable achievement of the Muktesar Laboratory during recent years, and the reports concerning its use, especially as compared with the results obtained with the "pillule" vaccine, are very encouraging.

(4) *Anti-anthrax serum.* 29,047 (5 c.c.) doses were issued to the field during the year.

Other sera and vaccines, manufactured on a smaller scale, are those employed for preventive inoculation against strangles, contagious bovine abortion and contagious equine abortion. Small quantities of special autogenous vaccines are also issued. Besides these products are manufactured for diagnostic purposes "mallein," "human tuberculin"; also "avian tuberculin" for the "intrapalpebral" or "double intra-dermal" test for Johne's disease. The revenue from the sale of the above products, for the most part to Provincial Governments and Indian States, in the two financial years 1925-26 and 1926-27 was Rs. 13,09,498 and Rs. 11,06,193 respectively, the estimated expenditure during these two years being Rs. 8,55,815 and Rs. 6,59,490 respectively.

Investigation of Animal Diseases.

There has been during the last five years a considerable expansion in the research activities of the Institute. The nature of this research need not be here specified as it has been dealt with in the section on "Veterinary Research in India." The examination of specimens of parasitic organisms and of morbid material forwarded by professional workers in the field as also the giving of technical advice have also come to constitute items of much importance in the routine work of the Institute.

Veterinary Education.

The Institute now provides courses of instruction for Officers of the Indian Veterinary Service and of the Royal Army Veterinary Departments. A strenuous endeavour has been made during recent years, with the limited staff available, to expand the natural functions of the Institute as a presiding centre of veterinary education and learning in India. The resources in the way of material are unique and it is believed that the training, particularly in practical methods of modern disease investigation, of selected subordinates from the Provincial and States Veterinary Departments would effectually conduce towards the dissemination of important information concerning the control of animal diseases in India.

The Branch Laboratory.

This laboratory is situated in the plains, sub-station at Izatnagar, at a distance of 3 miles from Bareilly on the R. & K. Railway. It was erected to relieve the parent laboratory at Muktesar of as large a portion as possible of the routine work of serum manufacture. The laboratory was started at Kurgaina as a small station for the carrying on of certain experimental work in the winter months. The possibilities of serum manufacture were seen later and in 1913 sanction was obtained from the Government of India for the purchase of an extensive plot of land amounting to 700 acres at Izatnagar and for the erection there of the necessary buildings. An advantage over manufacture at the parent laboratory is the decreased cost due to saving of expenses incurred in the transport of food-stuff for animals and men from the plains and the higher rates paid for labour.

Bengal Veterinary College, Belgachia.

Bihar and Orissa Veterinary College, Patna.—The Province of Bihar and Orissa has as yet no veterinary institute of its own, but Government recently sanctioned a scheme for a college and research institute on what is known as the Phulwari site about a mile west of the new city (Patna). The construction of buildings has already commenced and it is expected that the College will be opened by the middle of 1929. In addition to

teaching and research, instruction will also be given in dairying and the handling of milk as it is proposed to have a large cattle breeding farm attached where the most modern methods in dairying and the distribution of milk will be demonstrated.

The Bombay Veterinary College.—This is an educational institution started in 1886 for the purpose of training veterinarians for service under Government, for service in Native States, and for private practice.

The course of study extends to three years and is essentially practical and not theoretical, especial attention being paid to attendance at hospital clinique, demonstrations and dissections. Teaching facilities exist at the College for about 100 students. Clinical instruction is given in the adjoining Bai Sakarbai Dinshaw Petit Hospital which is managed by the Bombay Society for the Prevention of Cruelty to Animals and which is affiliated to the College for this purpose. The diploma of qualification is "Graduate of the Bombay Veterinary College" and is awarded after a full course of study at the College to students successful at the final examination.

The College buildings consist of class rooms, a museum—library, lecture theatre, chemical laboratory, etc., as well as an operating theatre and forge, etc., etc. The Sir Dinshaw Maneckjee Petit Patho-Bacteriological Laboratory is situated in the Hospital Compound and is utilised for instructional purposes. There is a students' Hostel affording accommodation to 76 students.

The Rai Sakarbai Dinshaw Petit Hospital for Animals, Bombay.

Madras Veterinary College.—This College was started in 1903 and it affords theoretical and practical instruction in subjects appertaining to the veterinary profession. It possesses a hospital and an up-to-date well-equipped laboratory. The course of study extends over three years. Forty students who are above 18 and below 22 years and who have passed the Matriculation Examination of an Indian University or obtained in the S.S.L.C. Examination the marks required to enable them to study

for the College course are admitted each year and 15 of them are given scholarships at the rate of Rs. 15 per mensem each. Tuition is free to all students who bind themselves to serve this Government for 5 years, if required, after completing the course. All others are to pay fees at the rate of Rs. 400 per annum.

A Post-graduate class is also held annually for 6 months and it comprises instruction (Practical and Theoretical) in Histology, Pathology, Medicine, Bacteriology, Parasitology (including Helminthology, Protozoology, and Entomology), Clinique, and Meat and Milk Inspection.

A hostel is attached to the College with accommodation for 63 students; but students are at liberty to make their own arrangements for their board and lodging.

The Punjab Veterinary College, Lahore.—Is among the best institutions of its kind in the East, or indeed in the World. The site occupied by the College with its various buildings comprises about 22 acres. The buildings consist of (*a*) the Main Block, a two storey building which contains the Museums, Students' Library, the Chemical and Physical Laboratories, some fine Lecture Rooms, the Principal and Clerks' Offices, etc., (*b*) the Hospital Section in which the latest model of X-ray apparatus is shortly to be installed, and which has a fine Operating Theatre, ample Hospital accommodation and Riding School, (*c*) The Anatomical and Physiological Section, both with modern equipment, the former having arrangements by which carcases can be preserved for several months without putrefaction for dissection purposes, (*d*) The Laboratory Section and Contagious Ward. In the former the subjects Bacteriology, Pathology and Parasitology are taught. It contains a remarkably fine Students' Class Room facing north especially adapted for laboratory work. This section is excellently equipped with collections of animal parasites, pathological specimens, etc. It prepares antirabic vaccine and other vaccines.

There is also a well-equipped Canine Hospital which is self-supporting and complete in all its requirements.

The Institution is primarily a teaching one but also carries out research. It has a highly trained staff and provides almost

unlimited variety of Clinical and Hospital practice for the students.

6. CHEMICAL EXAMINERS AND PUBLIC ANALYSTS DEPARTMENT.

In each Presidency there is a Chemical Examiner or Public Analyst Department where medico-legal and certain other kinds of work are carried out. In addition there is at Calcutta the Imperial Serologist who carries out Precipitation and other Serological tests especially in relation to medico-legal work. Among such departments may be mentioned:

The Chemical Examiner's Laboratory, Rangoon.—This Institute is essentially a Medico-Legal Laboratory engaged in detection of poisons, examination of blood and seminal stains in criminal cases. In addition examination of opium and cocaine and other important excise work is carried out.

Chemical Examiner's Department, Punjab, Lahore.—Is under an Officer of the Indian Medical Service assisted by four officers selected from the Punjab Civil Medical Service. The Laboratory deals with Northern India, the work being (*a*) medico-legal, (*b*) miscellaneous. In 1926 the following examinations in the first class were made (for Punjab only), murder by violence 373, rape 219, unnatural offences 96, other human 584, cattle 43. Poisoning is roughly 30 per cent. suicide, and 70 per cent. homicide. Suicides favour opium and homicides arsenic, datura and mercury. The report of the Chemical Examiner is accepted as evidence in all Courts. Under miscellaneous were 1,458 articles examined for Public Health, Excise, Drugs and Explosives. Research work is also carried on.

Public Analyst to Government, United Provinces.—Analyses samples of food and drugs received from official inspectors of localities to which the provisions of the U. P. Prevention of Adulteration Act, 1912, have been extended. The Act is in force in 61 municipalities, 8 notified areas and 3 districts. Private analyses are also carried out on receipt of the prescribed fees. The work is carried out in the buildings of the Lucknow University.

7. AGRICULTURAL AND FOREST INSTITUTIONS.

There are a number of large Agricultural Research Institutes in India and a large Forest Research Institute at Dehra Dun as well as Agricultural Colleges and Forest Colleges. The following may be mentioned:

Government of India, Agricultural Research Institute, Pusa.—The Agricultural Research Institute, Pusa, owes its inception to the generosity of Mr. Henry Phipps, an American philanthropist, who, in 1903, placed at the disposal of Lord Curzon, the then Viceroy and Governor-General of India, a donation of £20,000 (which he afterwards raised to £30,000) to be devoted to some object of public utility in India, preferably in the direction of scientific research. Part of this donation was devoted to the construction of a Pasteur Institute at Coonoor in South India, and it was decided that the balance should be utilized in erecting a laboratory for agricultural research which would form a centre of economic science dealing with the development of agriculture on which the people of India mainly depend. This conception was subsequently enlarged, and a college and research institute, to which a farm of 640 acres is attached for purposes of experimental cultivation and demonstration, was established at Pusa under the control of the Central Government.

The Institute is fully equipped with laboratories, a museum, herbaria, and an up-to-date scientific library. The activities of the Institute are mainly directed towards research, experiment and education.

As regards research, the Institute deals as a rule with problems of general or All-India importance, or with problems which can not be studied properly or conveniently by Provincial Departments. On the educational side, it serves the purpose of a higher teaching institution, providing post-graduate courses for selected graduates of provincial agricultural colleges and distinguished science graduates of Indian Universities. With a view to the ultimate Indianization of the department and to obviate the necessity of students going to foreign countries for still higher agricultural teaching.

PLATE XIII.

His Excellency the Viceroy inspecting the cross-bred cattle at the Imperial Institute of Animal Husbandry and Dairying, Bangalore, in July 1927.

specialised courses were started in November 1923, with the object of training students in methods of research and fitting them for appointment to the superior posts in the service. Since its conception, nearly 400 students have taken advantage of the training given at the Institute.

The Institute publishes in the form of scientific memoirs and bulletins the results of research work carried out by members of the staff and by research workers in the provinces. It also publishes a bi-monthly Agricultural Journal which contains articles on different phases of Indian agriculture and a quarterly journal of the Bureau of Animal Husbandry and Dairying, which deals with questions relating to cattle breeding, dairying and animal nutrition.

The Institute performs another very important function in so far as it supplies information and advice on agricultural topics to all who care to ask for it.

The Institute is under the administrative control of the Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa, and its staff is divided into six sections, which deal with agricultural, botanical, chemical, mycological, entomological and bacteriological problems. Pusa is the head-quarters, too, of the Sugar Bureau which was established in 1919 to collect and disseminate information relating to the Indian sugar industry. The various activities of the Institute are described below:—

Agricultural Section.—The activities of this section are mainly directed towards demonstrating the possibilities of large scale cultivation by machinery and modern implements, the production of cheap fodder and the improvement of cattle by selection, better feeding and cross-breeding. By selection, breeding and better feeding the milk yield of the herd of Montgomery cows on the Pusa Farm has been doubled within the last 15 years; while one of the cross-bred Ayrshire-Montgomery cows has given 12,000 lb. in one lactation.

Botanical Section.—The activities of this section are directed towards the production of seed of improved varieties of crops. It has evolved various types of wheat which are known as

Pusa wheats. These are now being grown on an area of about one and a half million acres.

Chemical Section.—This section deals with investigations of fundamental importance in various branches of agricultural chemistry, e.g., the water requirements of crops, the movements of soil moisture, the loss of nutrients in drainage water, the availability of plant food materials in different types of soils, etc. These researches have helped to place the study of scientific agriculture in this country on a broader basis.

Mycological Section.—The chief function of this section is to investigate the conditions most suitable for the development of fungi responsible for various diseases of cultivated crops and fruit trees, and to evolve measures for preventing or controlling such diseases. The section has accumulated a valuable collection of specimens of Indian parasitic fungi.

Entomological Section.—The activities of this section include an insect survey and researches on the life-histories, bionomics and control measures of insect pests of plants. The problems also include the study of insect carriers of diseases, and life-histories and bionomics of many biting flies are being worked out. There is in the section an excellent collection of Indian insects which have been arranged in show cases. Plates illustrating life-histories, habits, etc., of the disease-carriers are also exhibited.

Bacteriological Section.—The primary function of this section is the bacteriological examination of soil with a view to determining the relationship existing between bacterial action and soil fertility. Work on this problem includes the study of the fixation of air nitrogen by soils, bacterial processes rendering such nitrogen available as a food for crops, and the various changes in the organic matter of the soil effected by micro-organisms.

Staff.

Director and Agricultural Adviser to the Government of India—D. Clouston, C.I.E., M.D., D.SC.

Imperial Agricultural Chemist and Joint Director—W. H. Harrison, D.SC.

Imperial Agriculturist—G. S. Henderson, N.D.A., N.D.D.

Imperial Mycologist—W. McRae, M.A., D.SC.

Imperial Entomologist—T. Bainbrigge Fletcher, R.N., F.L.S., F.E.S., F.Z.S.

Imperial Economic Botanist—F. J. F. Shaw, D.SC., A.R.C.S., F.L.S. (on leave).

Imperial Agricultural Bacteriologist—J. H. Walton, M.A., M.SC.

Second Entomologist (Dipterist)—P. V. Isaac, B.A., M.SC., F.E.S.

Agronomist—Aga Mohamad Mustafa, B.A.

Physical Chemist—Dr. A. N. Puri.

BENGAL.

Agricultural Farm, Dacca.

Cinchona Plantation, Mangpu.

BOMBAY.

Agricultural College, Poona.

CENTRAL PROVINCES.

The Agricultural Research Institute, Nagpur, contains laboratories for research work in agricultural chemistry and bacteriology, botany and mycology. It is surrounded by a botanical garden laid out on systematic lines and is also in close proximity to the College farm, this farm providing areas where experimental work in the field can be carried on. Pending further developments, the Agricultural Research Institute also affords accommodation for the laboratory work carried on by the Civil Veterinary Department.

The main problems under investigation in the Agricultural Research Institute, Nagpur, are those dealing with the fertility of soils, biological changes taking place in the soils, the improvement of the staple crops of the province and diseases affecting these crops. There is also a small entomological laboratory on the College Farm for the study of crop pests. The Agricultural Chemist acts as Public Analyst under the Central Provinces

Prevention of Adulteration Act, 1919, and the analytical work involved is carried out in the Agricultural Research Institute.

MADRAS.

Agricultural College and Research Institute, Coimbatore.—This institution opened in 1908 is the successor to an older institution at Saidapet, near Madras and stands on extensive grounds with a large farm of about 500 acres and up-to-date Dairy. It is situated three miles west of Coimbatore Railway Station. It is a residental institution with well equipped laboratories and halls, quarters for research officers and teachers and a hostel for 120 students.

During the past 15 years one crop after another has been taken up for detailed study in separate small areas and there are breeding stations for sugar-cane, paddy, cotton, and millets. The Herbarium contains about 60,000 sheets of South Indian plants and is in close touch with Kew. The Pathological and Chemical Sections pursue their line of work in Soil Chemistry, Soil Physics, Soil Bacteriology and Animal Nutrition in special laboratories and culture houses. A matter of special interest to medical and other people is the investigation of the effect of manuring a crop on the quality of the resulting seed both from the point of view of plant and animal nutrition.

On the Educational side, the College is affiliated to the Madras University and prepares students for a Degree in Agriculture known as B.Sc.Ag. This institution serves as a heart centre for diversified activities of the Agricultural Department which are manifest in mofussil stations in important tracts.

Madras Forest College, Coimbatore.—Opened in July 1912, in the Old Municipal Hospital—transferred to the present site in October 1915. The College course is of two years' duration. Approximately 5 months of each year are spent in camp, this period being devoted primarily to practical work. Three categories of students are admitted, viz., students already in Government service, students deputed by Native States and outside Provinces and private students so far as vacancies after satisfying (1) and (2) may exist. Students already in

Government service in Madras are designated Probationary Rangers and are given a salary of Rs. 65 per mensem. The following certificates are granted by the College: The Honours Certificate, the Madras Ranger Higher Certificate, the Madras Ranger Lower Certificate. There is a principal, 2 senior instructors, 1 junior instructor and 1 curator of the Gass Forest Museum.

NORTH-WEST FRONTIER PROVINCE.

Experimental Farm, Turnab.—About 5 miles from Peshawar. Is in charge of the Agricultural Officer of the Province.

PUNJAB.

The Agricultural College and Research Institute, Lyallpur.—The College gives several courses of instruction to students in those sciences having a direct bearing on Agriculture. Most of the students take the B.Sc. Degree course (running over four years) in which specialisation in different branches of agricultural science is possible, while others take the Leaving Certificate course extending over two years. There is another short course of six months in the vernacular for the sons of farmers.

The experimental research station comprises Botanical, Agricultural, Chemical and Entomological Sections in which research in these sciences bearing on Agricuture is carried out.

Special interest attaches to the Entomological Section whose activities are especially connected with the investigation and control of insect pests and the study of their life-history and habits. This section also carries on work on the destruction of rats, which are responsible for enormous damages to field crops and act as carriers of plague.

The Chemical Section is more particularly engaged in investigations on the nutritive values of Indian food-stuffs. The work involves a large number of analyses of different feeds, fodders, etc., together with actual digestibility trials. A large scheme of work is at present in progress being an investigation into the nutritive values of different fodders and natural pasture grasses available in the Punjab, in order to co-relate climatic and soil

conditions with nutritive value of the food. The Chemical investigations are carried out at Lyallpur whilst Biological examination of the nutritive values of some of the wheats grown under different conditions of irrigation are being conducted at the Deficiency Diseases Laboratory of the Pasteur Institute, Coonoor. The work is also being extended to natural agricultural pastures in certain parts of the Punjab, particular attention being given to the mineral content.

There are other investigations of Agricultural importance to which the institution is giving attention, namely, the important question of Kallar soils and the waterlogging of soils, which has a direct bearing on the rural population and its health. The development of Kallar on the land deprives the zamindar of considerable area which reduces his income, while waterlogging aids the spread of malaria which is rampant in many parts of the Punjab and seriously affects the efficiency of the people.

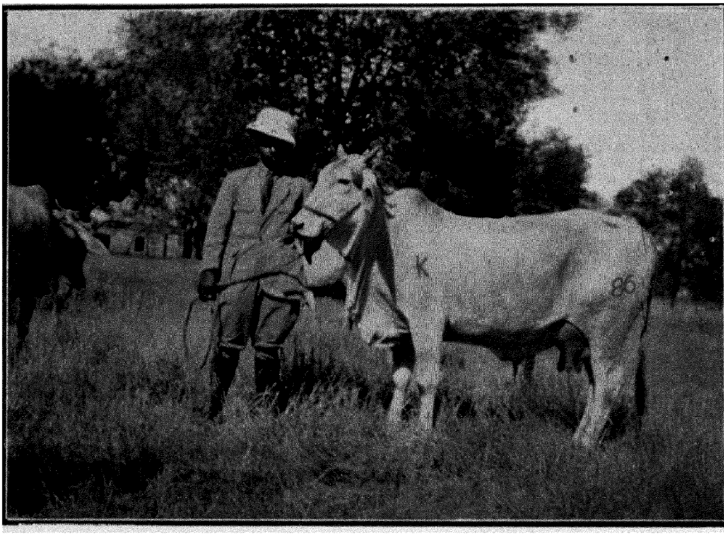
The Engineering Section of the college is largely occupied with well-boring and lift-irrigation and is developing its activities in this direction year by year.

UNITED PROVINCES.

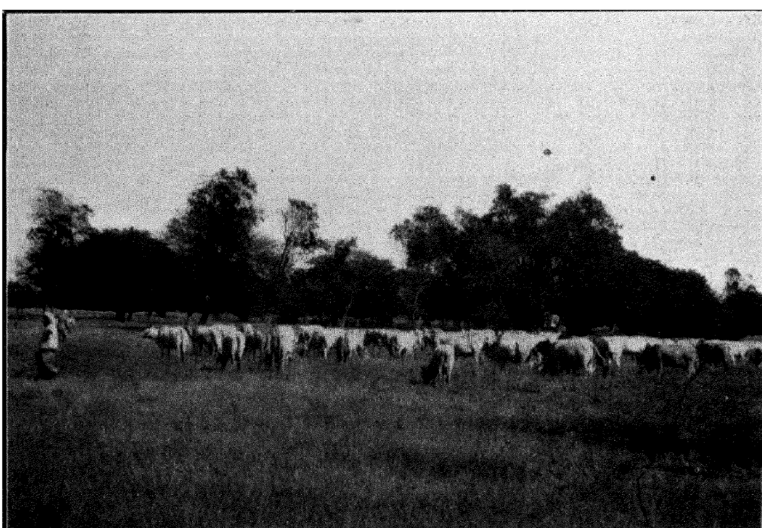
Cawnpore Agricultural College.—The College is an admirably equipped institution erected at an initial cost of about 16 lakhs. There are two courses, the one leads to the Intermediate Standard after 2 years and then after 2 further years to the L.Ag., which is recognised as equivalent to the B.A. Degree. This is intended for larger landlords and as a training ground for the staff of the Agricultural Department. The other course is a vernacular course lasting two years. The laboratories attached to the College are fully equipped for Technical Research with provision for chemical, botanical, pathological and entomological work. Researches carried out include investigation of the pink boll worm pest of cotton, work on sugar-cane, rice, barley and oilseeds, potato storage, mosaic disease in sugar, etc.

Vocational School, Bulandshahr.—Here sons of small zamindars and well to do cultivators can obtain certificates after a training of 2 years. As a result of public demand a new school on similar lines is being established at Gorakhpur.

PLATE XIV.



Thar-Parkar cow at the Imperial Cattle Farm, Karnal.



Herd of pure bred Thar-Parkar cattle at Imperial Cattle Farm, Karnal.

*

Government Farms.—There are 7 research and experimental farms in the Province, 17 seed and demonstration farms and 7 demonstration plots. There are two extensive Cattle Farms in Muttra' and Kheri Districts and a third is expected to be established this year in Bundelkhand. These farms issue bulls for breeding purposes and last year 100 bulls were distributed.

8. 'SCIENCE AND TECHNICAL INSTITUTIONS.

Among such institutions that may be mentioned are:

Government of India, Indian School of Mines, Dhanbad.—This institution has recently been established by the Government of India at the important railway centre of Dhanbad (E. I. R.) for the training of students for the professions of Mining Engineer and Geologist. As far as possible it is hoped to provide a counterpart of the Royal School of Mines in London. The School consists of two main buildings, the School proper and the Hostel for the students, who are resident throughout their training. There is at present accommodation for 150 students, the yearly capacity being about 50. There are in addition mechanical and electrical workshops. The buildings including the residences of the staff are electrically lit and the Hostel has been provided with a modern sanitation scheme which is under the administration of the Public Health Department. There is a resident assistant surgeon and a hospital with isolation wards. The School is situated close to the Jharia Coalfields and within easy reach of other important mining centres, it is also within close reach of the head-quarters of the Department of Mines in India. Although the School was only opened in November 1926, and is therefore not yet fully equipped, either in respect of staff or apparatus, the building is complete and the laboratories and workshops can be visited by anyone interested.

BENGAL.

University of Science, Calcutta.

Bengal Technical Institute, Calcutta.

Bengal Engineering College, Calcutta.

Dr. Rabindra Nath Tagore's Santi-Niketan, Bolepur.

Bose Research Institute, Calcutta.—The Institute was founded by Sir J. C. Bose for post-graduate research. The recent investigations carried out at this Institute establish the wide generalisation of the fundamental unity of plant and animal life. Investigation on the physiological mechanism of simple vegetable life has led to the better understanding of the more complex mechanism of animal life. The advance of knowledge has been rendered possible by the invention and construction at the Institute, of numerous automatic recorders of high sensitivity and precision. Among these, the *Electric Probe* localises the nervous tissue in the interior of the plant, as also the layer of cells whose throbbing pulsation causes propulsion of sap. The *Resonant Recorder* inscribes time as short as a thousandth part of a second, enabling the most accurate determination of velocity of nervous impulse in plants. The *Photosynthetic Recorder* automatically inscribes on a revolving drum the carbon assimilation in plant and exhibits the extraordinary great increase in its power of assimilation produced by infinitesimal traces of certain chemical substances. The *Magnetic Grescograph* enables movements, which are beyond the highest powers of the Microscope to be detected and recorded. The magnification produced can be carried to fifty million times. The imperceptible rate of growth and its induced variations under chemical or electric stimulants can be instantly measured.

The specific action of a drug can be immediately detected by its action on the pulse-beat of plant and animal. The pulsating organ of the plant was first subjected to the action of the drug; parallel experiments on the animal heart gave results which are extraordinarily similar. The recently invented *Resonant Cardiograph* inscribes the different phases of the heart-beat with unprecedented accuracy, the successive dots in the record measuring time as short as a hundredth part of a second. A very extensive field of investigation has been opened out on the action of extracts from various plants, the medicinal properties of which had not hitherto been suspected. By the employment of some of these the heart-machine can be regulated, enhancing or lowering its activity.

A complete account of these investigations will be found in the following books published by Messrs. Longman Green & Co. Copies can be had at the Institute.

(1) Response in the Living and Non-Living; (2) Plant Response; (3) Comparative Electro-physiology; (4) Irritability of Plants; (5) Physiology of Ascent of sap ; (6) Physiology of Photosynthesis; (7—10) Life Movements of Plants, 4 Vols.; (11) Nervous Mechanism of Plants; (12) Plant Autographs and Their Revelations.

Bengal Chemical and Pharmaceutical Works, Calcutta.

BOMBAY.

Royal Institute of Science, Bombay.

Sydenham College of Commerce and Economics, Bombay.

Victoria Jubilee Technical Institute, Bombay.

Sir J. J. School of Art, Bombay.

Dharamsi Morarji Chemical Works, Bombay.

Bhandarkar Oriental Institute, Poona.

CENTRAL PROVINCES.

Victoria College of Science, Nagpur.—At a public meeting held in Nagpur on March 6th, 1901, it was decided to raise subscriptions in order to perpetuate the memory of the late Queen-Empress. For this purpose, a society was formed under the name "The Central Provinces Victoria Technical Institute," which formulated a scheme for the furtherance of scientific and technical education in the province. It was decided to construct a building for the location of an Institute which should include accommodation for the teaching of Physics and Chemistry and the allied sciences to the B.Sc. students of the two Arts Colleges in Nagpur: To this end, the governing body of the Institute paid Rs. 75,000 to the Local Government, being half the cost of a combined building for a Scientific Library, the Agricultural College, and lecture rooms and laboratories for imparting instruction in Physics and Chemistry.

The building was opened in October 1906, and in 1908 the classes were raised to the status of a separate College which was affiliated up to the D.Sc. Standard of the Allahabad University. On severing its connection with Allahabad University in August 1923, the College was admitted to the privileges of the Nagpur University, and is affiliated up to the D.Sc. Standard in Physics, Chemistry and Mathematics.

The College is maintained by the Local Government. Only the above three subjects are taught so that up to the B.Sc. course the College works in connection with the two local Arts Colleges. A Scientific Library is situated in the same building and students have easy access to advanced text-books and copies of current scientific periodicals.

The total numbers of students on the rolls at present is 190, and for the last four years the laboratory accommodation has been taxed to its utmost limit. A handsome and commodious new building is in process of construction, which it is hoped, will be ready for occupation in July 1929. This will accommodate about 400 students, and provision will also be made for Botany and Zoology up to the D.Sc. Standard, and English to the B.Sc. stage.

The number of members on the Teaching Staff in Physics is 4, Chemistry 5, and Mathematics 3. The fees for all classes are Rs. 90 per annum, the same as in the Arts Colleges, and no extra charge is made for laboratory instruction. The laboratories are well-equipped and it is hoped to organise research on a proper basis when the new building is ready.

A new hostel, capable of accommodating 104 students, was opened in July 1927.

Schools of Handicrafts and Industrial School.—There are three Government Schools of Handicrafts at Nagpur, Jubbulpore and Akola, and 4 aided Industrial Schools at Amraoti, Saugor, Dhamtari and Chandametta (in the Chhindwara District). The object of the schools is to take the sons of carpenters and blacksmiths and train them in the use of improved tools and methods, to teach them to draw to scale and to understand scale drawing,

to teach them quick methods of calculating, and the English names of tools and materials, to enable them to acquire a knowledge of the properties of materials, from whence derived, and how manufactured, so that they will leave the school with hands and intelligence so trained as to make them immediately of substantial use as craftsmen. Pupils who have passed the 4th Standard Vernacular and are between 16 and 19 years of age are admitted in these schools. Preference is given to sons of artisans.

A special course of 3 years is introduced in the Nagpur School as an experimental measure for backward pupils to combine general education with technical training.

BIHAR AND ORISSA.

The Indian Lac Research Institute.—The Indian Lac Association for Research was formed in 1921 as a result of a report by Mr. Lindsay, C.B.E., I.C.S., and Mr. Harlow, I.F.S., which was called for by the Government of India. It was decided to build and equip a Lac Research Institute and to run in conjunction with this a small experimental plantation. The Institute including laboratories for biochemistry and entomology was finished in 1925 and the plantation of about 80 acres was started in 1924.

Lac consists of a resinous substance formed by a small insect on various but not all species of trees, and shellac is the manufactured article from this. The work of the Institute consists in an endeavour to obtain some insight into the methods of production of lac in all its aspects.

MADRAS.

College of Engineering, Madras.—The College is situated on the south bank of the Adyar River, about six miles south of Madras. The grounds occupy about 200 acres. It is a residential college having its own hostel, dining rooms and kitchens with accommodation for 450 students. The buildings are the College, Physical and Chemical Laboratories, Electrical, Strength of Materials, Hydraulic and Mechanical Laboratories, Machine Shops, Carpenter's Shop, Smithy, Foundry, Power House, Survey Stores

and residential quarters for the staff. The Power House is equipped with steam engines, semi-Diesel engines and suction gas engines. Current is supplied to the College laboratories and grounds for lighting and power, to Government House and the Teacher's College for lighting and to the King Institute of Preventive Medicine for refrigeration and lighting purposes. There is an independent water-supply, and a sewage system of the latest water-borne design consisting of underground drains, pump house, septic tank, Imhofi tank, an ærobic sprinkling bed, etc. A sub-assistant surgeon is provided with quarters in the compound and there is an up-to-date dispensary and a hospital with 8 beds.

MYSORE.

The Indian Institute of Science, Bangalore.—The Indian Institute of Science owes its origin to the genius and munificence of the late Mr. Jamsetjee Nusserwanjee Tata, who in 1896 proposed to vest in trustees properties to the capital value of 30 lakhs. Effect was given to these proposals by his sons Sir D. J. Tata and Sir R. J. Tata, contributions being also made by the Mysore Government and the Government of India.

The Institute is essentially a posy graduate institution having for its particular object the promotion of advanced studies and original research with special regard to the educational and economic interests of India.

As now organised the Institute comprises a Department of Electrical Technology, a Department of Biochemistry, a Department of General Chemistry and a Department of Organic Chemistry.

The Department of Electrical Technology has been established with the twofold object of (1) providing advanced courses of instruction in the subject, (2) affording to students who have undergone a course of training facilities for carrying out original investigations.

The Laboratories of the General and Organic Chemistry Department are intended for students who wish to take up research work in these subjects. The laboratories offer facilities

for training in analytical work and in addition possess a unique collection of small scale plants by means of which operations may be carried out with several hundredweights of material. Among subjects investigated are the production of white lead, chromates, alumina, caffeine from Indian materials, the distillation of sandal-wood oil and the destructive distillation of Indian woods.

The Department of Biochemistry provides full facilities for graduates wishing to take up work in bacteriological and enzyme chemistry, the chemistry and biology of water and sewage, plant chemistry, certain aspects of agricultural chemistry, fermentation problems, etc. The department is well equipped with general biochemical apparatus. New laboratories have recently been provided with apparatus for various physical measurements required in biochemistry, etc.

The Institute possesses a first class scientific library. It publishes *The Journal of the Indian Institute of Science* and *Electrotechnics*. There is a hostel for students and tennis courts, billiard room, library, etc., for the use of the students.

As a result of the Institute's researches manufacturing concerns, such as factories for white lead production, distillation of sandalwood oil, etc., have been instituted in Mysore.

UNITED PROVINCES.

Thomason Civil Engineering College, Roorkee.—The necessity for the systematic training for Civil Engineers in India led to the establishment of this College in 1848. It has met the needs of the whole of Northern India for training in Civil Engineering.

The Marris College of Hindustani Music.—Was established at Lucknow in July 1927, to further and develop Indian Music in Schools.

The Hindustani Academy.—Has recently been established. Its main object is to stimulate the production of original works in Urdu and Hindi with a view to develop and enrich the literature of these languages.

9. EDUCATIONAL INSTITUTIONS.

There are 15 Universities in India, viz., those of Calcutta, Madras, Bombay, Punjab, Allahabad, Benares Hindu, Mysore, Patna, Osmania, Dacca, Aligarh Muslim, Rangoon, Lucknow, Delhi and Nagpur. There are 34 Medical Colleges and Schools, 13 Law Colleges, 20 Agricultural Colleges and Schools, 22 Training Colleges for secondary teachers and 141 Commercial Colleges. Of secondary schools there were in 1923-24, 2,424 and of primary schools 168,013 with 6,955,634 scholars. Of Educational Institutions that may be specially mentioned are:

ASSAM.

Cotton College, Gauhati.—This College was established in 1901 as a purely Government institution during the administration of Sir Henry Cotton, after whom it was named. It is affiliated to Calcutta University up to the M.A. Standard in English (Group A), to the B.A. and B.Sc. Pass and Honours stage in English, Economics, Mathematics, Philosophy, History, Sanskrit, Persian, Physics and Chemistry. In Intermediate Arts and Science it is affiliated in Botany in addition to the foregoing subjects. There are two separate hostels for Hindus and Mohammedans under the supervision and management of four resident superintendents giving accommodation for 308 boarders. The staff consists of the principal, assisted by 17 professors and lecturers.

Murarichand College, Sylhet.—Founded in 1886 by Raja Girish Chandra Roy, Zemindar of Sylhet, the Murarichand College became provincialized in 1912 and has since made rapid progress. New buildings were completed in 1925 and the College is now established in them some three miles from the town of Sylhet, in its own extensive grounds covering nearly 200 acres.

Students are prepared for the Intermediate Arts and Science, and for the B.A. and B.Sc. examinations of the Calcutta University. It is affiliated up to the Honours standard in English, Mathematics, Sanskrit, Arabic, Persian, Economics, History and Philosophy, Physics and Chemistry. The total enrolment is about 550 and about a quarter of the students reside in College hostels.

It possesses a large library and well-equipped laboratory. The staff consists of 17 professors and 7 lecturers, two being members of the Indian Educational Service, and three possessing European qualifications.

BENGAL.

Calcutta University.—The Calcutta University was founded in 1857 and is located at College Square, Calcutta. Of the University College of Science—the Physics and Chemistry branch is situated at 92, Upper Circular Road, Calcutta, and the Botany and Zoology branch at 35, Ballygunge Circular Road. The University buildings consist of the Senate Hall (built in 1874), the Dharbanga Library Building (built in 1912) where the University Office is held, the Asutosh Building and the Hardinge Hostel. The University was at first an examining body, but, since passing of the Indian Universities Act of 1904, which made provision for the Indian Universities making arrangements for teaching and research work, the Calcutta University was transferred, through the genius of late Sir Asutosh Mookerjee, into the biggest and foremost teaching University in India. The Post-graduate Department of the University provides for and guides research work in various branches of studies and has produced valuable results, notably in Physics, Chemistry, Botany, Anthropology, Ancient Indian History and Culture and Philology. Among the Professors of the University are Professor C. V. Raman, M.A., D.SC., F.R.S. (Physics), Sir P. C. Ray, *Kt.*, C.I.E., D.SC., etc. (Chemistry), Professor P. Brühl, D.SC., etc. (Botany), Professor B. K. Das, D.SC. (Zoology), Professor S. Radhakrishnan (Philosophy), Professor D. R. Bhandarkar, PH.D. (Ancient Indian History and Culture), Professor Abanindranath Tagore, D.Litt., C.I.E. (Indian Arts), Dr. Sunitikumar Chatterjee, M.A., D.Litt. (Indian Linguistics and Phonetics).

The University confers the following degrees:—B.A., B.Sc., B.T., B.L., M.L., M.A., M.Sc., D.Sc., M.B., D.P.H., M.O., M.S., M.D., B.E., Ph.D., D.Sc. (Engineering).

The University Law College is located in the Darbhanga Library Building. In Medicine, there are two Colleges, viz.,

(1) the Medical College (a Government Institution), Calcutta, and (2) the Carmichael Medical College at Belgachia in the northern suburbs of Calcutta, affiliated to the University to teach up to the M.B. Degree. The M.B. Degree course consists of 5 stages, viz., (1) Preliminary Scientific M.B. Examination—one year (Physics, Chemistry, Zooloogy and Botany), (2) First M.B. Examination—two years (Anatomy and Physiology), (3) Second M.B. Examination—one year (Pharmacology and Materia Medica and Elementary Bacteriology and Pathology), (4) Third M.B. Examination—one year (Forensic Medicine and Hygiene and Public Health), and (5) the Final M.B. Examination—one year (Medicine, Surgery and Midwifery).

For the degrees of M.O., M.S. and M.B., which may be called post-graduate degrees in Medicine, candidates are required to submit as part of their examination a thesis embodying their research work in a specified subject. Candidates who appear at the D.H.P. Examination generally receive their instruction in the School of Tropical Medicine, Calcutta.

The University Library which is located in the Dharbanga Library Building consists of more than 120,000 volumes in all subjects mainly Arts and receives about 180 Periodicals and Journals.

There is also another Library in the Post-graduate Department of the University which issues books to the Post-graduate Students for study at home. This Library has about 17,958 volumes (including Journals and Periodicals).

The University has also a Museum of Fine Arts Collection representing the Indian Fine Arts in its different stages. In the Bengali Manuscript Department of the University, there are about 700 volumes of Manuscripts of Bengali texts, old and mediæval.

The University has a Press of its own, which publishes not only the theses submitted by winners of University Research Scholarships and Doctorate degrees but also rare and valuable treatises and original researches bearing on various branches of Indological studies. About 400 books have been published from the University Press up-to-date. The Calcutta Review, the Journal of Indian Chemical Society, the Philosophical Magazine,

the Journal of Letters and the Journal of Science are among the periodicals published in the University Press.

Presidency College, Calcutta.

St. Xavier's College, Calcutta.

University of Dacca.

BIHAR AND ORISSA.

Pátna College.—This College, which is maintained by Government, may be said to have taken the place in Bihar of the Presidency College, Calcutta, in Bengal. Such a statement now requires qualification, however, in view of the fact that, with effect from this year (1927-28), the I.Sc., B.Sc. and M.Sc. classes have been removed; and a separate Science College has been constituted, incorporating these classes, Patna College henceforward, therefore, will consist of Arts Departments only, except for Science teaching in Geography, up to the I.A. Standard. There is provision for 300 I.A. and 300 B.A. (including those who are reading for Honours) students; and the full number is likely to be realised from next year. There is provision also for post-graduate teaching in the following subjects, viz., English Literature, History, Economics, Sanskrit, Persian, Philosophy and Mathematics (the B.A. Honours work and the M.A. work in this subject being done in the Science College). In all, there is provision for 180 students, proceeding to the M.A. Degree.

The sanctioned strength of the teaching staff is a principal and 36 professors, assistant professors and lecturers.

There are at present three Hostels attached to the College affording residential accommodation for about 250 students. When full effect has been given to proposals already sanctioned, however, there will be Hostel accommodation for nearly 350. There are residences for the principal and three professors.

The College possesses a library containing upwards of 16,000 volumes; a gymnasium; a commodious Students' Common Room; and adequate playing-fields. Games and drill are compulsory; and there are active Students' Societies, like the Debating Society, the Archæological and Historical Society, and the Chanakya (Economics) Society.

There is a number of Junior and Senior Scholarships, most of them worth Rs. 10 to Rs. 12 a month, tenable at the College.

The institution was opened in February 1860, as a Government School under the Local Committee of Public Instruction. In September 1862, it became a Collegiate School; and it was raised to the status of a College on the 1st January, 1863. A Law Department was added in May 1864; and an Engineering Department in July 1896. These now form separate colleges, as does also the Science College to which reference has been made above. The Collegiate School became a separate institution in 1910.

The building is generally supposed to have been a Dutch Factory. It was used as the office of the Collector of Patna from 1828 onwards. The first addition made to the original structure was the west wing, built in 1871. In 1880—82, the east wing, and the portico and main staircase, were added; and a separate Science Building, connected with the main building by a covered colonnade, was built. The two main College hostels date from 1908; and new Science Laboratories were opened in 1915. Very considerable additions to the College buildings have been made during the past two years.

Patna College was affiliated to Calcutta University up to 1917. On the foundation of Patna University on the 1st October, 1917, it became a constituent college of this University.

Patna Training College.—This College for the training of " English Teachers " for the higher classes in High Schools was started by the Government of Bengal in 1908 to supplement the work of the other Training Colleges and was for some years affiliated to the Calcutta University and taught only up to the standard of the Licentiate in Teaching. When the province of Bihar and Orissa was established it was felt that the College should be further developed, and in 1915 classes for preparing graduates for the B.T. Degree were opened. The College came under the Patna University from the date of its establishment in 1917 and has since then taught the course prescribed by the Patna University.

At present there are 44 students in the College taking the Diploma course and 4 taking the B.Ed. The syllabus followed is prescribed by the Patna University and consists, in the Diploma course lasting one academic year, of (1) the History of Educational Ideas, (2) The Principles and Methods of Teaching the usual High School subjects, (3) Hygiene and Physiology (elementary) as required for school work, (4) The Principles of Education. (5) Practical Work, including Demonstrations, Criticism lessons and Practical lessons. The B.Ed. course involves a more advanced study of parts of the above course, e.g., mental tests, etc., and specialized practical work.

The staff consists of a principal and 4 professors. There is a hostel for 40 students each having his own room, and residences for the principal and three professors; there is also a High School attached to facilitate the Practical Work, with a hostel for the boys and a residence for the Headmaster. Fields for games are being acquired adjoining the compound.

BOMBAY.

Bombay University, Bombay.
Indian Women's University, Bombay.
Government Law School, Bombay.
St. Xavier's College, Bombay.
Elphinstone College, Bombay.
Wilson College, Bombay.
The Deccan College, Poona.
Ferguson College, Poona.
The Gujrat College, Ahmedabad.

CENTRAL PROVINCES.

Morris College, Nagpur.—Was founded in 1885 with funds raised to commemorate the long connection of Sir John Morris with these provinces as Chief Commissioner. Until 1915 its affairs were managed by a Council of Eight, with Sir Bepin Krishna Bose as Secretary, and it is to him the College owes its present prosperity. Now it has grown beyond the capacity of private funds and is a Government institution. It has more than

500 students on its rolls of whom about 50 are in post-graduate classes. Its staff consists of 26 members including Science teachers who work under the auspices of the Victoria College of Science but teach Morris College students. It is situated in the historic Residency round which the battle of Sitabuldi was fought in 1818 and has a large Hostel in its grounds.

The Hislop College, Nagpur.—Is the only non-Government College in the Province. It is financed to the extent of more than one-third of the expenditure by contributions received from the United Free Church of Scotland. The institution derives its name from the Rev. Stephen Hislop, the eminent geologist and antiquarian. Situated as it is, and always has been, in the city, the College has played a prominent part in the life of Nagpur. Very many of the leaders in the public life of Central Provinces received their education in whole or in part in this institution. Alone of the Colleges affiliated to the University of Nagpur, it offers courses of Biology. By means of public lectures and in other ways, the Hislop College has borne its part in the work of University extension.

Robertson College, Jubbulpore.—This College which is affiliated to the Nagpur University up to the B.A. and B.Sc. Degrees, is a residential institution, beautifully situated near a lake four miles out of Jubbulpore in about two hundred acres of park land. It is a self-contained unit with a Dispensary controlled by a sub-assistant surgeon. A careful system of physical examination is maintained and a campaign against Malaria is lessening the ravages of that disease. So far it has been found proof against Plague, Cholera, and other prevalent epidemics. It has the longest history of all the Colleges in the Central Provinces.

King Edward College, Amraoti.

Spence Training College, Jubbulpore.—This is a Government College for training teachers and has accommodation for about 125 students. Courses are provided for both graduates and under-graduates, the former being prepared for the L.T. Degree of Nagpur University. Besides attending lectures and tutorial

classes students are required to teach under the supervision of the staff, in the Model High School attached to the College. A course in physical training is compulsory for all students and games of all kinds are encouraged. The weights and measurements of students are regularly recorded. Training in Scoutmaster's work is also provided for students interested in Scouting.

Reformatory School, Jubbulpore.—This has accommodation for 200 juvenile offenders and was started in the year 1891, in the enclosure, formerly occupied by the School of Industry for *thugs* and dacoits. It is a philanthropic institution founded by Government for improving the lot of those unfortunate boys, who fall into bad company and commit crime. The institution was first started under the Jail Department, but was transferred to the Education Department in 1900, with a view that educative methods may help in converting these criminals into useful citizens, and certainly it did so. Besides being taught to read and write, they were taught carpentry, tailoring, gardening, smithing, cloth weaving, cane work, painting and shoemaking, but in later years, as the numbers decreased, the last 5 trades were discontinued, and the institution was again transferred in 1918 to the Department of Industries.

There is a hospital attached to the institution. The boys are allowed to play football and other outdoor games, besides going through a course of physical exercises daily.

In conclusion, it gives me much pleasure in giving below the following remarks recorded by General Booth Tucker, when he visited the institution some years back:—

"It is certainly one of the best managed and appointed Reformatories we have seen in India, and we wish it every success."

MADRAS.

The Presidency College, Madras, was founded 74 years ago and has occupied the present buildings since 1870. It is a constituent College of the Madras University and gives instruction up to the B.A. Honours and M.A. Standard in

Mathematics (Pure and Applied), Physics, Chemistry, Botany, Zoology, Geology, Philosophy, History, Economics, English and Sanskrit: instruction is given also in Latin, Tamil, Telugu, Canarese, Urdu and Malayalam. The students number 950 and the teaching staff 60. There is a general library and also departmental libraries for each of the above subjects: they contain in all 23,300 volumes. There is a small hostel managed by the College and another 200 students live in the Victoria Hostel within sight of the College. There is provision for cricket, football, hockey, tennis and badminton. The College magazine is published terminally.

NORTH-WEST FRONTIER PROVINCE.

Islamia College.—Is an important educational institution near Peshawar.

UNITED PROVINCES.

The University of Allahabad.—The University was founded in 1887 and was until 1921 an examining and affiliating university of the type of the old London University. In 1921 the University was reorganised with a view to establish at Allahabad, a unitary, teaching and residential university. At the same time it continued to exercise control over the colleges affiliated to it. These colleges, which formed the external side of the Allahabad University, have with effect from July 1927, been transferred to the Agra University. The Allahabad University provides also facilities for post-graduate research in Science, History and Economics.

The Agra University.—This is a purely affiliating and examining university of the type of the old Allahabad University and has been established with effect from July 1, 1927. It has taken over the academic control of the colleges previously associated with the University of Allahabad on its external side.

Lucknow University.—This is a unitary, teaching and residential university of the same type as the reorganised Allahabad University. It provides the same facilities for teaching and

research as are provided by the Allahabad University. A special feature of the University is the King George's Medical College, and Hospital, Lucknow.

Benares Hindu University, Benares.—Is a unitary, teaching and residential university for all India. It provides instruction in the same subjects as the Allahabad University but has two special features: (1) its Engineering College providing instruction in the various branches—Mechanical, Electrical, Mining, Metallurgy of Engineering, and (2) the Faculties of Oriental Learning and Theology which provide facilities for research in Sanskrit and allied studies.

The Aligarh Muslim University, Aligarh.—Is a unitary residential and teaching university of the same type as the Benares Hindu University, i.e., an All-India University, and provides facilities for instruction and research in Arts, Science, Law, Commerce and Theology.

Reformatory School, Chunar.—The Reformatory School has been in existence since 1902. It is meant for the reformation of juvenile offenders who are trained at the school in some trade or profession which will enable them to earn an honest livelihood.

10. LEARNED SOCIETIES.

Asiatic Society of Bengal, Calcutta.—Founded in 1784 by Sir William Jones as the Asiatic Society. The Society has its buildings at No. 1, Park Street, Calcutta. It holds a Monthly General Meeting on the first Monday of each month. The Medical Section of the Society meets separately. With the transference of the Society's biological, geological and archæological collections the Indian Museum (in Chowringhee) was started in 1875.

The Society's Library contains about 100,000 volumes; it is especially rich in Scientific Serials. Its manuscript collections include about 15,000 in Sanskrit and 5,000 in Arabic and Persian. It possesses also a priceless collection of copper-plate grants and inscriptions. On its walls are many valuable paintings, including two Joshua Reynolds (one of the Founder of the Society), a Guido Reni and a Morland. The statues include two by Chantry.

The Society publishes two periodicals, "Memoirs" and "Journal and Proceedings," a continuation of the "Journal" (1832—1904) and "Asiatic Researches" (1788—1839).

The Bombay Branch Royal Asiatic Society, Bombay.—The Society was instituted in 1804, under the name of the Bombay Literary Society, for the investigation and encouragement of Oriental Arts, Sciences and Literature; but since its incorporation in 1830 with the Royal Asiatic Society of Great Britain and Ireland it has been denominated as the Bombay Branch of that Society. The Bombay Geographical Society has been amalgamated with and forms a Geographical and Natural Science Section of this Society. The objects of the Society are (*a*) to investigate and encourage Sciences, Literature and the Arts in relation to Asia and in particular to India and to promote research therein, (*b*) to conduct a Journal, (*c*) to publish works embodying research, and (*d*) to maintain a general library.

Bombay Natural History Society.—Founded in 1883 to promote the study of Natural History in all its branches. Has a membership of about 1,700 and a museum with extensive collections a large part of which have recently been moved to the Natural History Section of the Prince of Wales Museum, Bombay. The Society publishes a well-known and valuable Journal.

Anthropological Society, Bombay.

11. MUSEUMS, BOTANIC GARDENS, LIBRARIES, ETC.

The Indian Museum, Calcutta.—A conspicuous large and massive building in Chowringhee facing the Maidan. Is the most important of all the Indian museums, being a centre for zoological and other research work as well as a place of exhibition. Has Zoological, Geological and Archæological Galleries, all of great importance; also Art and Industrial Sections. Special interest attaches to the collection of Siwalik fossil mammals from the famous bone deposits in the Siwalik Hills at the foot of the Himalayas and to the Indian sculptures brought from various archæological sites, etc. There are also Ethnographical, Economic

and other galleries. The Museum possess a very fine Zoological Library and large collections stored for purposes of research. In connection with the Museum is the *Zoological Survey of India* also the *Mammal Survey*. The offices of the *Geological Survey of India* are located in the Museum compound.

The Royal Botanic Gardens, Sibpur, Calcutta.—Situated on the west bank of the Hooghly. The gardens cover 270 acres and have a frontage of a mile along the river. The gardens are arranged in the main to bring plants growing in the same regions together. Among objects of interest is an ancient banyan tree which with its offshoots covers ground 1,000 feet in circumference. In the gardens is the Herbarium, well known to botanists, containing unique collections of plants. The Superintendent of the Gardens is also the Director of the *Botanical Survey of India.* In association with the department are *Cinchona plantations* notably that at *Mungpu*, near Darjeeling.

Imperial Library, Calcutta.—This, the largest library in India, was formed at the instance of Lord Curzon, when Viceroy and Governor-General of India, but the amalgamation of the Calcutta Public Library and the Government of India Secretariat Library of the time. The latter had grown out of a number of separate departmental libraries, the library of the Home Department, Foreign Department, etc. The Library is especially strong in the class of books and pamphlets dealing with India. In manuscripts the Library is not very rich, but there is a very valuable collection of Arabic and Persian MSS., and a collection of Sanskrit MSS. There are fair beginnings of collections of prints and maps. The catalogues of the Library form a body of bibliographical material of very great value.

The Library, as well as having reading rooms at the Foreign and Military Secretariat (in Esplanade Street) which are open to the general public exclusive of those under 18 years of age, is a lending library, and as such sends its books all over India, Burma and Kashmir and occasionally even further. There is no charge made for using it. The entire cost of the Institution is borne by the Central Government.

The Prince of Wales Museum of Western India, Bombay.

The Victoria and Albert Museum, Bombay.

Victoria Gardens, Bombay.

Meteorological Observatory, Bombay.

Central Museum, Lahore.

Phayre Museum, Rangoon.

Museums also at Lucknow, Nagpur, Bangalore and chiefly or entirely archæological at Delhi, Muttra, Sanchi, Sarnath, Udaipur, Baroda, Jaipur, Peshawar, Trivandrum and elsewhere.

Zoological Gardens at Calcutta, Bombay, Karachi, Rangoon, Lahore, Madras, Bangalore, Trivandrum, and elsewhere.

Botanical Gardens at Calcutta, Bombay (Victoria Gardens), Madras (Horticultural Gardens), Bangalore, and elsewhere.

The Marine Aquarium, Madras.—This is more than a mere place for sight seeing and will be found well worth visiting. It is on the sea-shore and exhibits tropical fish, etc., caught in the locality.

12. SOME INDUSTRIAL AND MUNICIPAL INSTITUTIONS OF MEDICAL OR SANITARY INTEREST.

BIHAR AND ORISSA.

Jamshedpur (Tata Iron and Steel Works).—In 1907 what is now Jamshedpur was jungle with a few small villages. In 1927 it is an industrial town of about 100,000 inhabitants, producing pig-iron, finished steel, such as rails, girders, section, and the like, tin-plate, electric cable and agricultural implements. There are now 5 Blast Furnaces, 50 Koppers and 150 Wilputte Coke Ovens with bye-product recovery plants attached making coke for the Blast Furnaces. There is a Sulphuric Acid Plant making sulphuric acid for the bye-product recovery plants and for pickling rolled sheets and tin-plates before coating with spelter

and tin. 700,000 tons of pig-iron and 400,000 tons of steel are produced annually.

The town is laid out on a rectangular gridiron plan regardless of natural features of the ground. There is accommodation for some 28,000 workmen in the Steel Works and 3,000 in the Tin-plate Works, etc. For each workman the total population includes at least two more persons, women, children, shop-keepers, tradesmen, and the like. In laying out the town the density of population is limited as far as possible to 12 families per acre.

Filtered water is supplied to all the western area of the town. The purification works deal with 2½ million gallons per day. Settling tanks, Patterson Filters and Chlorinating Plants of a modern type are in use. Almost all the new town and a large part of the old is served by an underground sewerage system. Many of the Indian quarters have wash-down privies connected to the sewers and houses without separate connections are served by public water-flushed trough pattern latrines. There are purification works, the effluent and sludge from which are used for irrigation and fertilisation of farm lands. The sewerage of some 6,000 persons is pumped by stereophagous pumps to a small Activated Sludge Plant which irrigates 30 acres and was put in as an experiment to see if the activated sludge system was suitable to India. With a view to comparing the working of the two systems a Simplex Plant was installed early in 1927 to deal with 40,000 gallons a day of the same sewage as that in the other system. Other sewage is still dealt with in temporary works some of which are only heaps of stones in which the nitrifying action is started.

The health of the town is taken care of by a Chief Medical Officer and 18 assistant doctors. There is one principal hospital consisting of an administration block and a ward block of 72 beds. A second similar ward block is being constructed. There are 3 outside Dispensaries and 3 First-Aid Dressing Stations. Free treatment is given to all employees and to all who attend hospital. There are 5 markets and a Dairy Farm with 125 head of cattle. Jamshedpur is the head-quarters of the Dhalbhum

Civil Sub-Division with an Assistant Magistrate and an Assistant Superintendent of Police. There are civil and criminal courts, a jail and Government hospital.

BOMBAY.

Bombay Municipal Water-Supply (Tansa Reservoir and Pipe Line). The chief source of the water-supply to the City of Bombay is the Tansa Lake which is situated at the foot of the Western Ghats about 55 miles to the north-east of the City. The lake is formed by a masonry dam about 2 miles long and 135 feet high. It impounds 35,604 million gallons of available water. The drainage area is 53 square miles including 7 square miles of water surface when the lake is full.

Until 1925 the water from the Tansa Lake was conveyed to the City through a conduit 55 miles in length formed partly of pipes 48 inches and 50 inches diameter and partly by a masonry aqueduct. The pipes are laid across the valleys and connect the various sections of the masonry conduit while the latter follows the contours of the hills which in several places have been tunneled through. In 1920 it was decided to increase the draught from the lake from 40 to 90 million gallons per diem and two new lines of 72 inches diameter mains each capable of discharging 45 million gallons per diem have since been laid, the whole masonry conduit and pipe lines being retained for future extension of the supply.

CENTRAL PROVINCES.

The Empress Mills, Nagpur.—Owned by the Central India Spinning, Weaving and Manufacturing Co., Limited. The Mills with its 5 Ginning and Pressing Factories in the mofussil were started in 1877 under the personal supervision of the late Mr. Jamsetji Nusserwanji Tata, the great pioneer of Indian industrial development. They occupy 186 acres of property and employ on an average 8,200 workpeople, turning out annually 98,56,000 lbs. of yarn for sale and 75,31,000 lbs. of cloth.

The success of the Empress Mills is chiefly due to the spirit of loyalty and efficiency created among the workpeople by incentives to skilled and steady work in the shape of prizes, bonuses,

prize distribution ceremonies and measures taken to ensure their safety and well-being. In all matters relating to the welfare of workpeople the Empress Mills have always been ahead of the times. They were the first in India to give proper care to ventilation and to install apparatus for humidifying the atmosphere in the dry hot climate. The Dust Removing Apparatus in the ginning factories and the Vacuum Stripping Apparatus for the card rooms of the mills prevent fluff and dust being inhaled by the workpeople.

There is a system of Long Service Bonus, a Sickness Benefit Fund, a Pension Fund, a Provident Fund, a Co-operative Credit Society and a Co-operative Stores for the benefit of the employees. There are 4 Dispensaries on the premises in charge of a qualified Medical Officer and a Lady Doctor, also Dispensaries at the 9 Welfare Work Centres and 3 Creches in the Mills' compound for babies of the women employees. Medicine and medical attendance are provided free and women employees in the family way are granted a maternity allowance of two months' leave with pay.

The Officers of the Mills are provided with commodious and sanitary quarters in the vicinity of the Mills. For the workpeople is a Model Village ultimately capable of housing 1,500 families with up-to-date modern sanitary and other conveniences. For officers there is a Library and Billiard Room and for the workpeople at each Welfare Centre an Institute and Primary School. Government Factory Schools and Private Schools attended by the children of the workpeople are also contributed to financially. For recreation the Mills have their own Cinema Machine and films. In the bustis sports are held and lantern lectures are given by the Y. M. C. A. through whose agency the Mills' Welfare Work is conducted. The Women's Welfare Work in the bustis is conducted by the French Sisters. From their inception to date the Mills have subscribed over Rs. 3 lakhs to various local and other funds, including famine relief measures, and relief measures to meet water scarcity in Nagpur.

The Central Provinces Portland Cement Co., Limited.—Is situated at Kymore. The factory is designed to yield 1,50,000

tons of cement per annum and is the largest works in India. The factory is equipped with a fine Laboratory and complete tests of the Raw Material, Clinker and Cement are carried out during the day and night. The Company also carry out researches on any points requiring investigations and are only too pleased to help intending customers at any time in this respect. "Swastika" brand is now well known throughout India and is used in all Government and other big Departments.

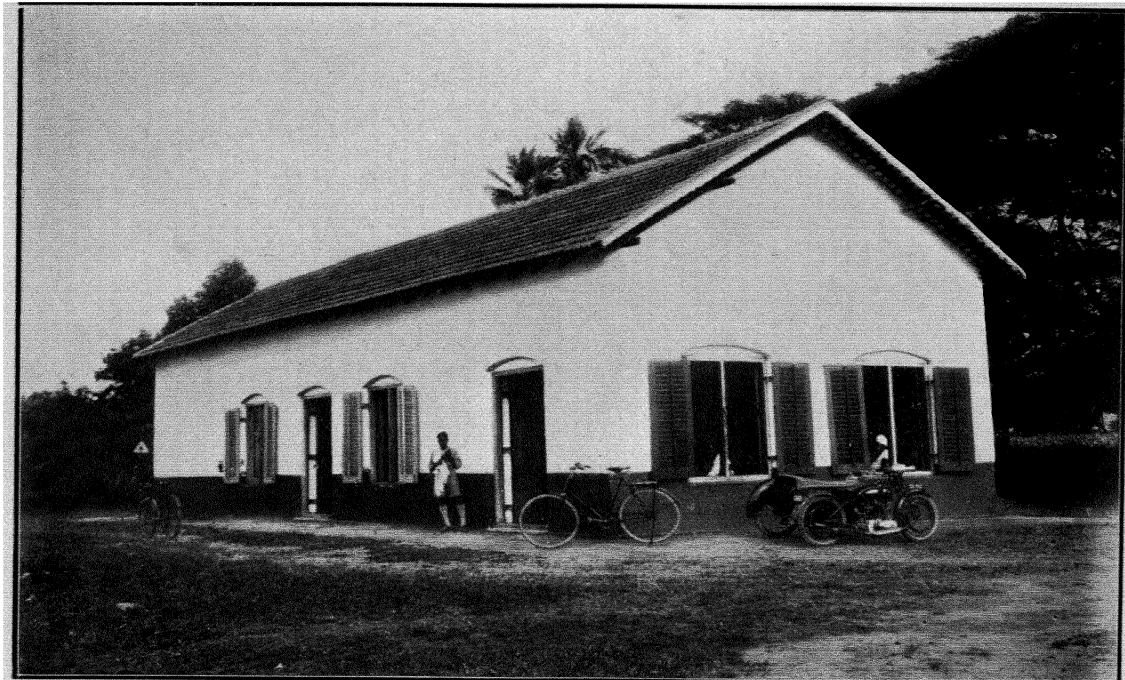
Messrs. Burn and Co., Ltd., Works, Jubbulpore.—The works at Jubbulpore were established in 1893 with the object of exploiting the excellent beds of Fireclay for which Jubbulpore is noted. The Company manufactures Stoneware Sanitary Pipes and Fittings, Refractories of all descriptions and Roofing and Flooring Tiles. During recent years the Works have been considerably enlarged and are in a position, owing to the proved quality of the clays discovered and the installation of the latest appliances, to produce articles as enumerated above which compare very favourably with the best known Home products. For many years most of the large Sanitary Schemes in Central and Western India have been carried out with materials supplied from Jubbulpore.

MADRAS.

The Buckingham and Carnatic Mills, Madras.—Educational and medical work at the Mills was placed on an organised footing in 1904. In 1914 the question of providing adequate and healthy housing was taken up. Since the war these matters have been actively pushed and in 1922 a Welfare Committee was instituted. This work now falls chiefly under the heads, Educational Dispensaries and Medical Attention, Gratuity Fund and Compensation Allowances, Provision of Chutrams (cooking and resting accommodation), Workpeople's Institute, Model Villages for workpeople and Savings Bank.

The total number of boys attending school is 1,300. Besides day schools there is a Technical School, a Night School and Special Classes. There is a Nursery Class attached to the day school. A Creche is not required as there are no inside women

PLATE XV.



In the first instance, the Imperial Sugarcane Breeding Station at Coimbatore was started only on a temporary basis. This is the small field laboratory—costing Rs. 2,500 in which all laboratory work at the station was done during the first fifteen years. The permanent buildings are now under construction.

workers. A school kitchen provides light refreshment at a nominal price and a mid-day meal is provided free to all boys who attend from a distance over 2 miles.

Each Mill has a dispensary in charge of a fully qualified doctor and medicines are supplied free. Each Mill is provided with a Chutram in which workpeople may cook and eat their meals and take rest. About 2—3,000 workpeople can be accommodated in each Chutram and there is separate accommodation for different castes. There are at present two villages attached to the Mills, and a Village Hall has recently been constructed. Arrangements for recreation include Sports, Dramatic Society, etc.

Cauvery Irrigation Project.—Consists of a dam across the Cauvery and Reservoir at Metur and a distribution system of canals for 300,000 acres of new irrigation in Tanjore. The dam will be the biggest in the world. A feature of the head-works, situated in a somewhat malarious tract, is the unusual care taken of the ordinary labourer. The temporary camp at headworks will contain from 5,000 to 8,000 coolies housed in good tiled sheds at a cost of Rs. 83 per head. Cholera being an annual occurrence, the camp will be provided with a chlorinated water-supply with Patterson Filters. The combined industrial and domestic supply is estimated to cost 9 lakhs and a drainage scheme and sewage farm 8 lakhs. The camp is being lit electrically. The completion of the work is expected in 1933.

Peryar Project.—The object of this project was to divert the water of an upper reach of the Peryar River from the west to the east coast. The object was achieved by damming the river at Peryar and lowering and tunneling under the watershed. The dam when constructed was one of the largest in the world and was built in spite of unprecedented difficulties due to the unhealthiness and remoteness of the locality. The result of the project which was completed in 1895 has been to convert the arid and famine stricken district round Madura into rich rice lands.

Nellikuppam Factory, near Cuddalore.—Owned by the East India Distilleries & Sugar Factories, Ltd., London, of whom the Managing Agents are Messrs. Parry and Co., Madras.

Sugar is produced by refining Palmyra jaggery (crude sugar) and from Sugar Cane which is grown round Nellikuppam. The Company grows several hundred acres of its own cane and carries out extensive experiments with a view to improve the quality of the cane. *Arrack* is distilled mainly from molasses obtained from the refinery. Denatured and rectified spirits are also produced for the local markets. *CO_2 Gas* is collected from the fermentation vats in the distillery and compressed into cylinders. *Confectionery* is made from the sugar produced in the refinery.

APPENDIX.

List of some useful books and publications on India.

General.

Murray's Handbook, India, Burma and Ceylon (gives a great deal of information about India in general).

The Indian Year Book (much general and statistical information).

* India in 1924-25, 1925-26, etc. (general and political).

* Handbook of Commercial Information for India (natural products and commercial organisation, etc.).

Imperial Gazetteer of India (a complete account of India in 25 volumes, of which the first 4 are Descriptive, Historical, Economical and Administrative). Also Provincial series with one or more volumes to each Province and District Gazetteers (some hundreds) giving detailed description of each District).

* General Catalogue of Government Publications (should be purchased by anyone interested in the obtaining of Indian medical or other reports—on sale at the Central Publication Branch, Hastings Street, Calcutta. Consult regarding Archæological, Botanical, Geological, Medical, Meteorological, Zoological Department publications, etc.).

Historical and Art.

A History of Sanskrit Literature, Macdonell.

Outline of religious literature of India, Farquhar and Griswold.

Oxford History of India, Smith.

Cambridge History of India, Vol. I. Ancient India, Rapson.

Historical Georgraphy of India, Roberts.

Indian Painting, Percy Brown.

Handbook of Indian Art, Havell.

The Charm of Indian Art, Solomon.

History of Indian Art and Eastern Architecture, Ferguson.

Agriculture, Veterinary and Irrigation.

Memoirs (also Bulletins and Scientific Reports) of the Agricultural Research Institute, Pusa. Also Report of the Progress of Agriculture in India (annual). See also General Catalogue.

Annual Reports of the Imperial Institute of Veterinary Research, Muktesar (Imperial Bact. Lab., Muktesar). See also General Catalogue.

Triennial Review of Irrigation in India, 1918-21. This is a special number giving a very full and illustrated account of Irrigation in India (Central Publication Branch, Calcutta).

MEDICAL.

Census of India, 1921 (Vol. I, Report, India) (also Provincial Volumes).

*Annual Report of the Public Health Commissioner with the Government of India (a summary of medical statistics and record of medical activities in India).

Annual Reports on Hospitals and Dispensaries, Reports of Directors of Public Health, Vaccination Reports. Reports of Chemical Examiners to Government (see General Catalogue).

Annual Reports of Bacteriological Laboratories and Pasteur Institutes (Calcutta School of Tropical Medicine, Haffkine Institute, Bombay, King Institute, Madras, and Pasteur Institutes at Kasauli, Coonoor, Shillong and Rangoon).

All-India Conference of Medical Research Workers (Annual).

Indigenous drugs of India, Marr.

Indigenous Systems and Medical Science, Burridge.

History of the Indian Medical Service, Crawford.

See also Indian Journal of Medical Research and Indian Medical Research Memoirs, Indian Medical Gazette, Public Health Bulletins (including publications of the Central Malaria Bureau).

---

*Obtainable at the Government of India, Central Publication Branch, Hastings Street, Calcutta.